AIIM

Association for Information and Image Management
1100 Wayne Avenue Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm
1 2 3 4 5
Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

DOCUMENT RESUME

ED 342 878 CE 060 074

AUTHOR	Sticht, Thomas G.
TITLE	Functional Context Education. Workshop Resource Notebook.
INSTITUTION	Applied Behavioral & Cognitive Sciences, Inc., San Diego, CA.
SPONS AGENCY	Ford Foundation, New York, N.Y.
PUB DATE	Mar 87
NOTE	90p.
PUB TYPE	Guides - Non-Classroom Use (055)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Adult Basic Education; Adult Literacy; Adult Programs; *Basic Skills; Case Studies; *Cognitive Psychology; Electricity; Electronics; *Employment Potential; Functional Literacy; Illiteracy; *Job Skills; *Job Training; *Literacy Education; Mathematics Skills; Military Training; Program Development; Reading Skills; Technical Education; Trade and Industrial Education; Vocational Education; Youth Programs
IDENTIFIERS	*Functional Context Education; Workplace Literacy

ABSTRACT

This notebook contains materials for a workshop to teach participants how to address the needs of youth and adults for improved literacy, employability, and productivity. Chapter 1 provides information about the current state of youth and adult literacy, employability, and productivity in the United States. Chapter 2 presents a conceptual framework, called "Functional Context Education" (FCE), for developing instructional programs for youth and adults that are based on the findings of cognitive and empirical research on literacy. Chapters 3, 4, and 5 contain three case studies that illustrate how concepts of FCE have been used to develop instructional programs for military and civilian populations: (1) Project FLIT (Functional Literacy), U.S. Army literacy programs for cooks, automotive repairers, and communication, medical, and supply clerk workers; (2) Experimental Functional Skills Programs, U.S. Navy reading and mathematics programs for career advancement using teachers, books, computers, and peers; and (3) "Cast-Off Youth: Policy and Training Methods from the Military Experience," a functional context electronics technician's course that integrates basic skills and basic electricity and electronics education. Chapter 6 discusses the need for a conceptual model of adult basic skills development, four principles for program development, and the Instructional Systems Development procedures for developing basic skills or other technical training in work settings. A list of 65 references is attached. (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED342878

FUNCTIONAL CONTEXT EDUCATION

Workshop Resource Notebook

Developed by:

Thomas G. Sticht
The Applied Behavioral & Cognitive Sciences, Inc.
March, 1987

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it

☐ Minor changes have been made to improve reproduction quality

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

T. Sticht

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CE060774

The Workshop on Functional Context Education has been made possible through a Ford Foundation grant to the Applied Behavioral & Cognitive Sciences, Inc. The contents and opinions presented in the workshop and associated materials do not necessarily reflect the judgements or opinions of the Ford Foundation.

BEST COPY AVAILABLE

ERIC

© Applied Behavioral & Cognitive Sciences, Inc.
1987

FUNCTIONAL CONTEXT EDUCATION

TABLE OF CONTENTS

FUNCTIONAL CONTEXT EDUCATION

Introduction

The Workshop on Functional Context Education (FCE) was developed by the Applied Behavioral & Cognitive Sciences, Inc. to provide participants with knowledge of use in addressing the needs of youth and adults for improved literacy, employability, and productivity. The goals of the workshop are to:

- Provide information about the current state of youth and adult literacy, employability, and productivity in the United States.
- Provide a conceptual framework called "Functional Context Education" (FCE) for developing instructional programs for youth and adults that are based on understandings of literacy from cognitive science and empirical research.
- Provide three case studies to illustrate how concepts of Functional Context Education have been used to develop instructional programs for military and civilian populations.
- Provide assistance to workshop participants in applying the Functional Context Education concepts to the needs for adult literacy development in their community.

The workshop includes lecture, discussion, demonstrations, and activities for participants. This notebook includes materials for the workshop. The materials include photocopies of some of the transparencies used in the workshop. Participants may use these materials after the workshop to provide information and assistance to others who may be interested in applying Functional Context Education to their adult education needs.

CHAPTER 1

YOUTH AND ADULT LITERACY, EMPLOYABILITY, AND PRODUCTIVITY PROBLEMS IN THE UNITED STATES

The major social problems that the Functional Context Education workshop addresses are the difficulties "mid-literate" youth (mid to late teens) and adults face in becoming and remaining employable and working productively in the face of changes in the nature of jobs and work in the "information age."

Literacy Levels of Youth and Adults

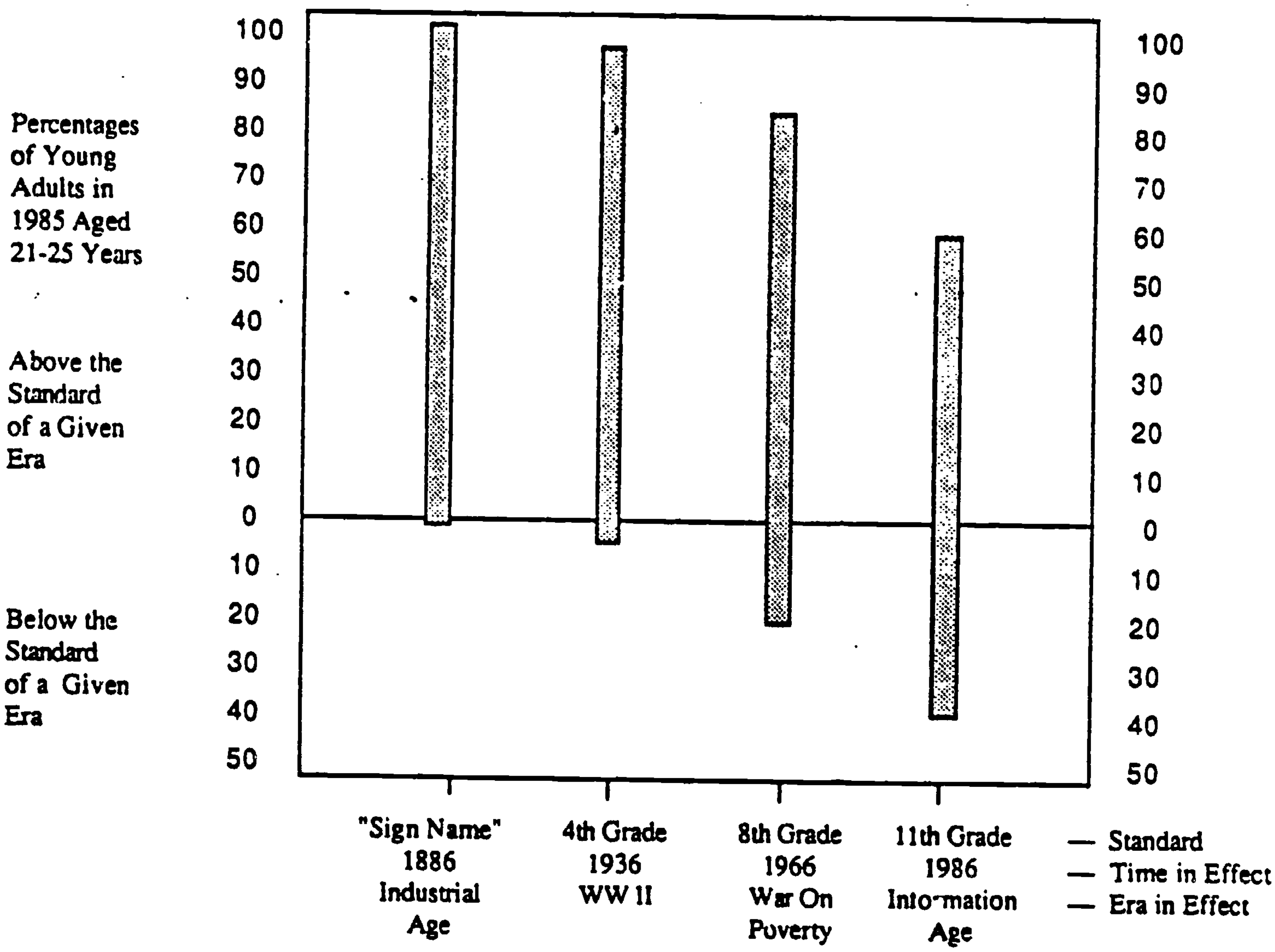


Figure 1.1

Data from the 1985 National Assessment of Educational Progress (NAEP) study: Literacy: Profiles of America's Young Adults. Percentage of young adults aged 21-25 years old scoring above or below the standards of literacy of 100, 50, or 25 years ago, and at the 11th grade level standard of contemporary times.

Using the data from the 1985 NAEP survey of adult literacy (Figure 1.1) fill in the blanks below:

Figure 1.1: NAEP data show that, of adults aged 21-25 years old,

__________% meet the standards of 100 years ago.

__________% meet the standards of 50 years ago.

__________% meet the standards of 25 years ago.

__________% meet the eleventh grade standard.

Discussion Questions: What should the current standard(s) of literacy be? How should standards be determined? By whom? For what purpose(s)?

Reading Levels of the Young Adult Population

Reading Grade Level[a]	Youth Population[b]		
	Number	Percent	Cum. Percent
3.0 - 4.9	1,222,196	4.8	4.8
5.0 - 5.9	1,276,924	5.0	9.8
6.0 - 6.9	2,010,967	7.9	17.7
7.0 - 7.9	2,682,034	10.6	28.3
8.0 - 8.9	3,333,267	13.1	41.4
9.0-9.9	2,766,213	10.9	52.3
10.0 - 10.9	3,542,121	13.9	66.3
11.0 - 11.9	4,105,026	16.2	82.4
12.0 - 12.9	4,470,047	17.6	100.0
Total:	25,408,795	100	100
Mean RGL: 9.4	Median RGL: 9.6		SD: 2.4

[a] Reading Grade Levels were estimated for the profile study sample using conversion tables for ASVAB 6 scores to ABLE reading test scores. The correlation between the scales in the test equating samp'e was .85.
[b] Restricted to persons in the sample born between January 1, 1957 and December 31, 1962 (18 through 23 years at time of testing, July-October 1980.

Figure 1.2

Department of Defense Study: Profile of American Youth: Reading Levels of the Young Adult Population, 18 through 23 Years of Age in 1980.

Another indication of the reading skills of young adults was obtained in 1980 in a national survey by the Department of Defense. In that year, a nationally representative sample of youth and young adults, 18 through 23 years old, were administered the Armed Services Vocational Aptitude Battery (ASVAB). Scores on

subtests of the ASVAB were converted to reading grade level scores. These scores are given in Figure 1.2. Use Figure 1.2 to complete the following:

Figure 1.2: Department of Defense data show that:

__________% of 18-23 year olds read below grade 5.0.

__________% read within the 5.0 and 9.9 grade range.

__________% read at or above the 10th grade level.

It is the roughly 50% of the young adult population who read between the 5th and 10th grade levels that make up the "mid-level literates" of concern in this workshop.

Discussion Questions: What about the almost 5% of young adults who read below the 5.0 grade level? Who is doing what for them? Should people who can read between the 5.0 and 9.9 grade levels be considered "illiterate" or "functionally illiterate?" Are they "literate?"

<u>Intergenerational Transfer of Literacy</u>

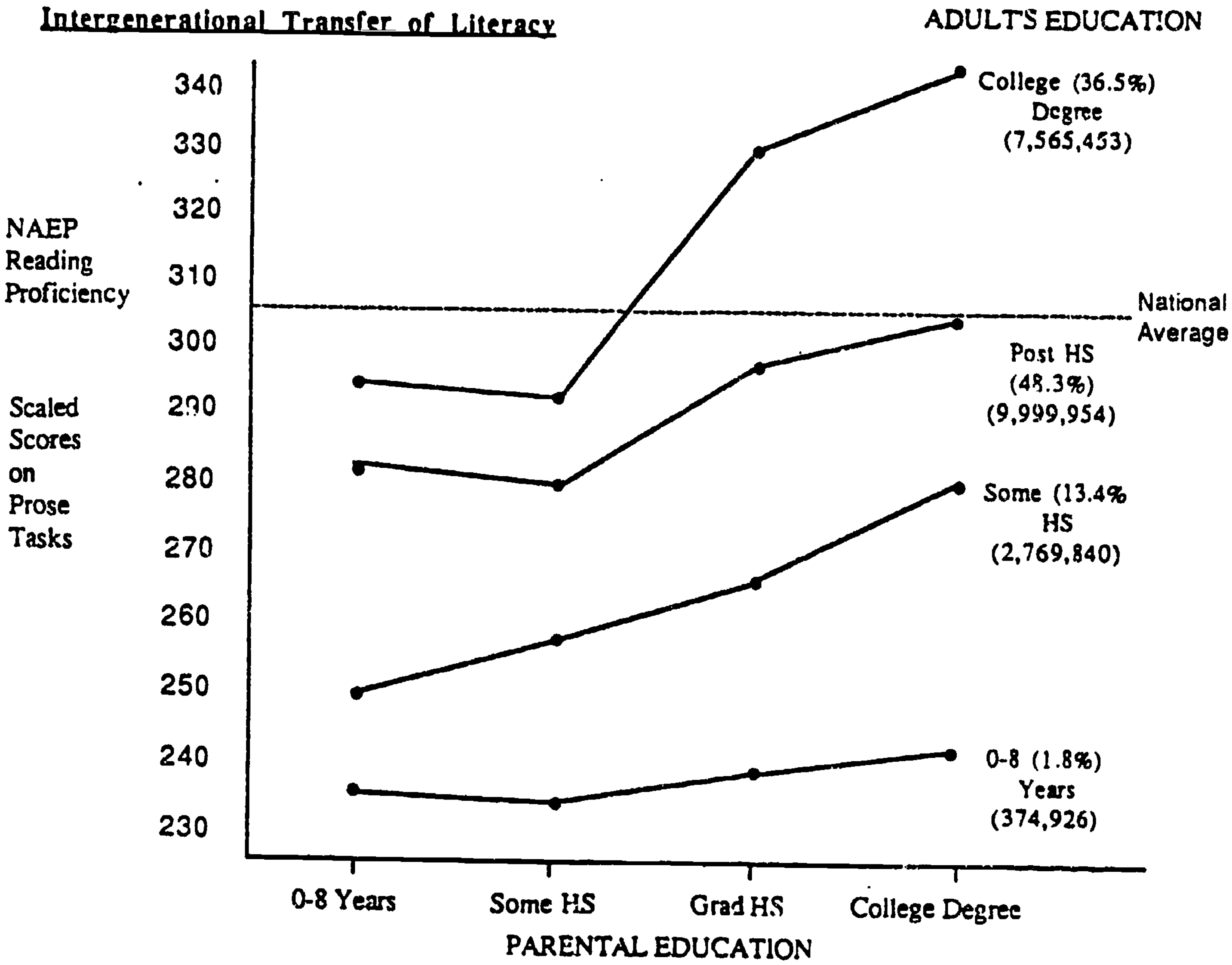


Figure 1.3

Performance of Young Adults (21-25 years of age) on the 1985 NAEP Prose Scale of Reading Proficiency as a Function of Parental Education (higher of mother's or father's) and the Person's Own Years of Education

Figure 1.3 shows that literacy achievement is strongly affected both by one's parent's levels of education and one's own level of education, with the latter being the most important determiner of literacy level. In Figure 1.3, young adults who completed only 0-8 years of education performed about the same on the literacy test regardless of their parent's level of education.

Discussion Questions: What might be the causes of the poor achievement of young adults who complete only eight years or less of education? Why is there such a large increase in literacy test performance of young adults with post-high school and a college degree when parent's education increases from some high school to graduate from high school?

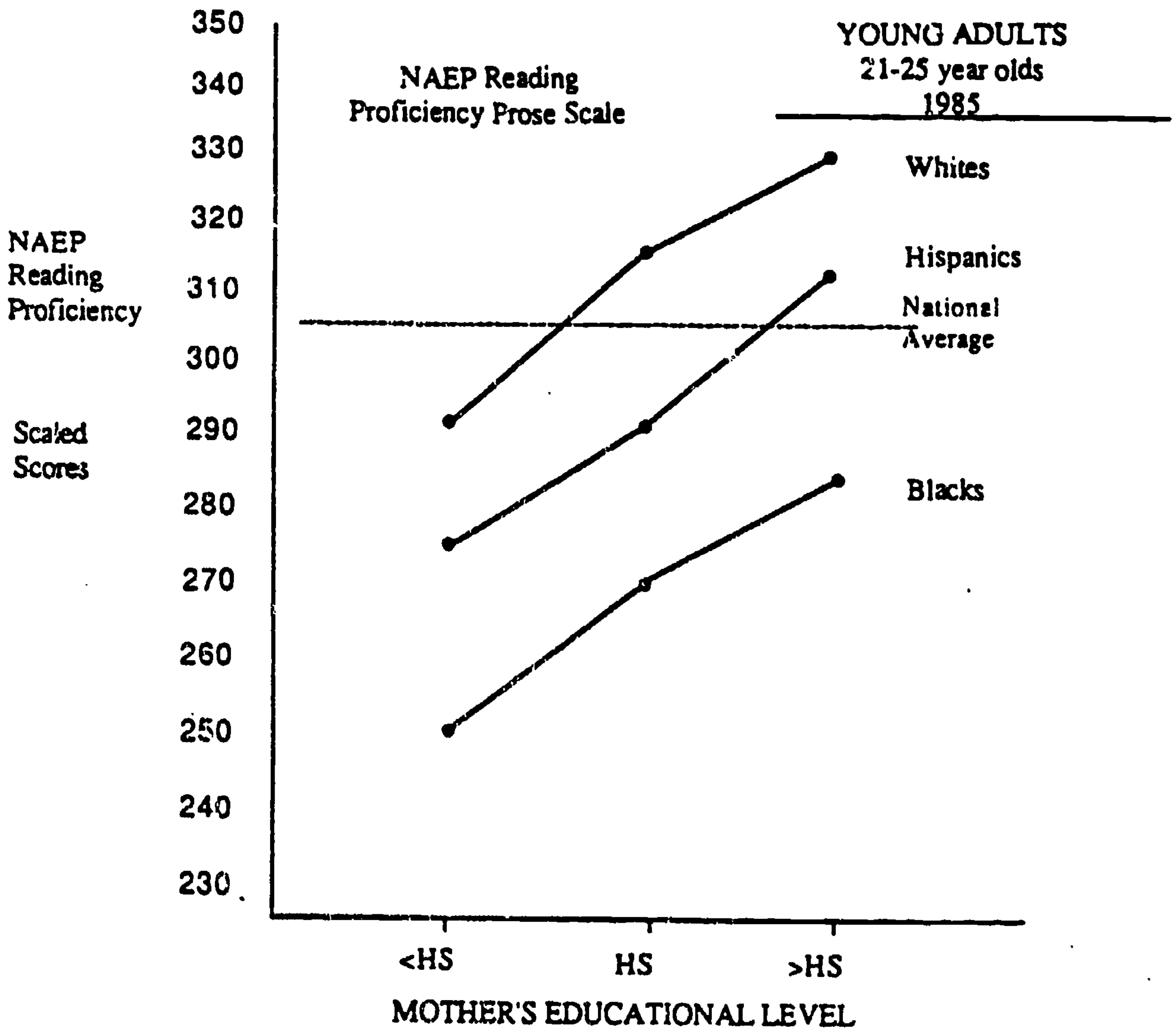


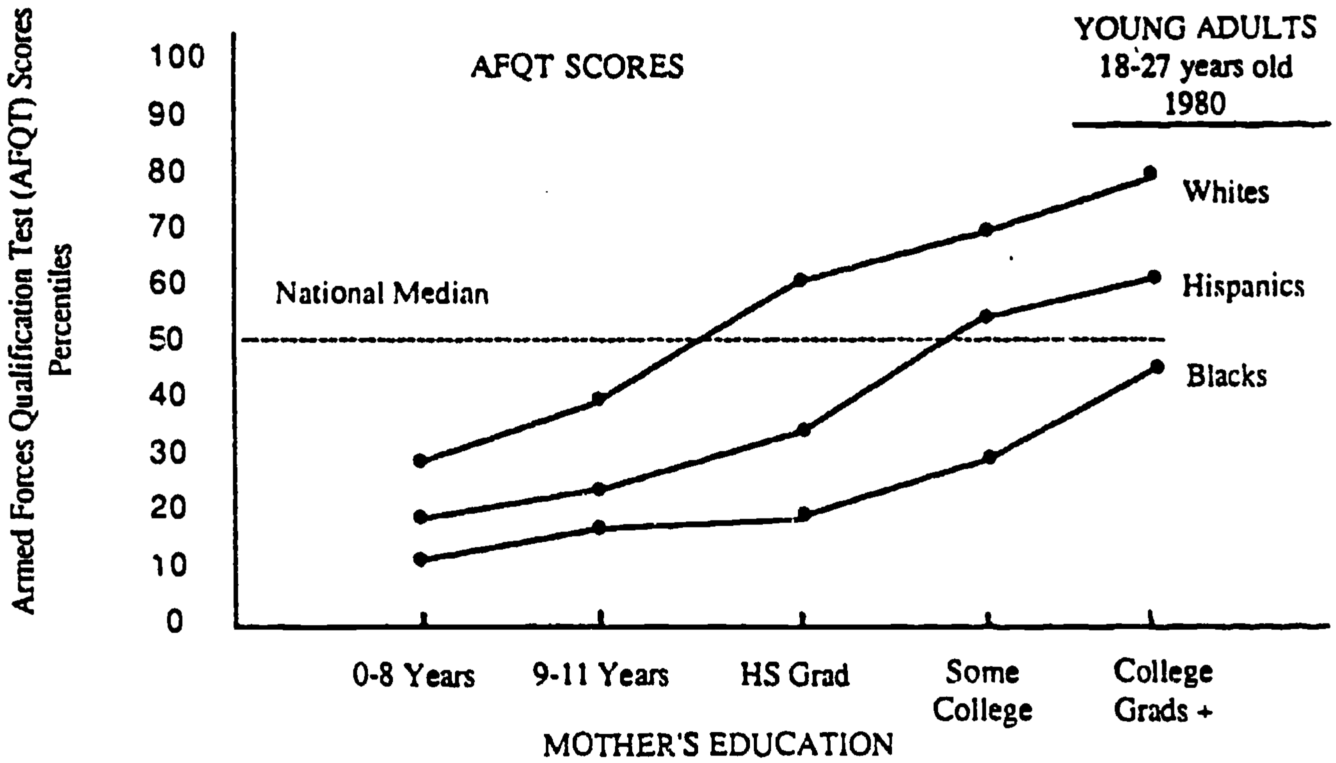
Figure 1.4

Performance of Blacks, Hispanics, and Whites on the 1985 NAEP Reading Proficiency Prose Scale as a Function of Mother's Education Level

Figure 1.5

Performance of Blacks, Hispanics, and Whites on the 1980 Department of Defense Youth Profile Study's Armed Forces Qualification Test of Reading (Word Knowledge and Paragraph Comprehension) and Mathematics (Numerical Operations and Arithmetic Reasoning—Word Problems) as a function of Mother's Education Level.

Department of Defense
National Survey of Performance on the
Armed Services Vocational Aptitude Battery (ASVAB)



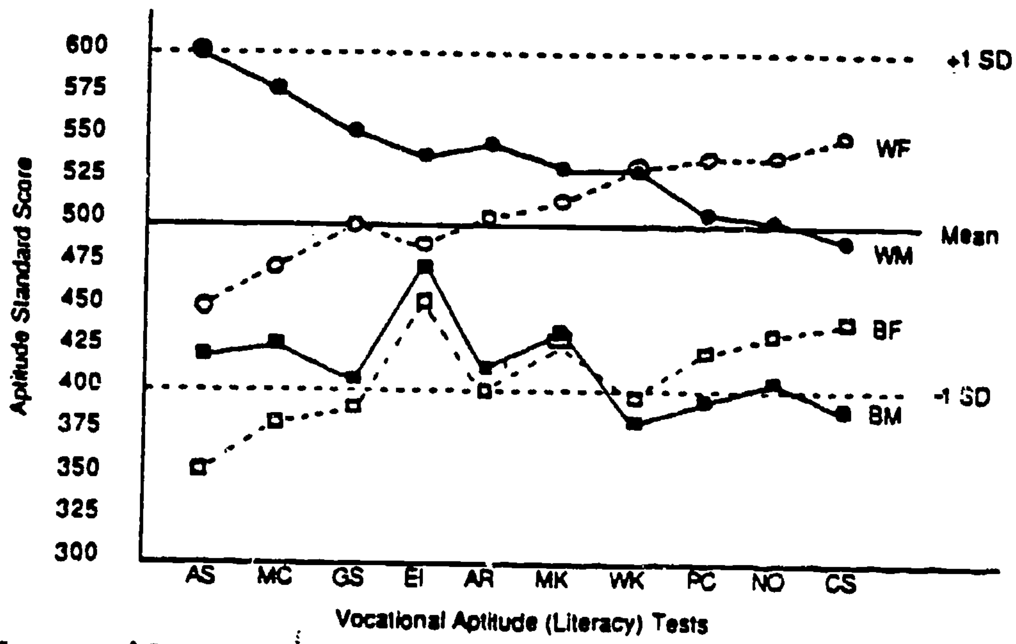
AFQT	CORRESPONDING BASIC SKILLS	
• Word Knowledge	• Vocabulary	READING
• Paragraph Comprehension	• Comprehension	
• Arithmetic Reasoning	• Word Problems	MATHEMATICS
• Numerical Operations	• Add, Subtract, Multiply & Divide	

Discussion Questions: Given the facts that (1) Blacks and Hispanics score considerably lower on literacy tests than do the White majority; (2) mother's education level is strongly related to literacy achievement in both minority and majority populations; and (3) the birth rates for Whites is considerably below that for minorities, what are the implications for U.S. literacy levels in the future? Why is there such a strong relationship between mother's education level and the literacy (including mathematics) achievement of children?

Employability of Young Adults

The employability of youth and adults is related to their levels of abilities and the demands of the academic, vocational, and technical training programs they must qualify for and complete to gain access to a job, and to the literacy and other cognitive, physical and social demands of the jobs themselves.

"Technological Literacy" Levels of Young Adults



Tests:			Legend:		
AS	-	Auto & Shop Information	WF	-	White Female
MC	-	Mechanical Comprehension	WM	-	White Male
GS	-	General Science	BF	-	Black Female
EI	-	Electronics Information	BM	-	Black Male
AR	-	Arithmetic Reasoning			
MK	-	Mathematics Knowledge			
WK	-	Word Knowledge			
PC	-	Paragraph Comprehension			
NO	-	Numerical Operations			
CS	-	Coding Speed			

Figure 1.6

**Performance of 1980 Young Adults (18-23 years of age)
on the Subtests of the Armed Services Vocational Aptitude Battery (ASVAB)
as a Function of Sex and Ethnic Status**

Figure 1.6 shows that (1) Blacks, males and females, score well below whites on all subtests of the ASVAB; and (2) females perform higher than males on low-level cognitive tasks (CS = coding speed; NO = numerical operations) and paragraph comprehension (PC) but drop well below males on the aptitude tests that are usually used to select people for technological training (AS = automotive & shop information; MC = mechanical comprehension; GS = general science; EI = electronics information; AR = arithmetic reasoning). This is true for both Blacks and Whites.

Discussion Questions: What are the implications of (1) the overall lower level of performance of Blacks, and (2) the lower "technological literacy" of females for gaining access to and performing well in technical training programs? Why are there more females in Word Processing jobs and more males in Automobile and Electronics Repair jobs?

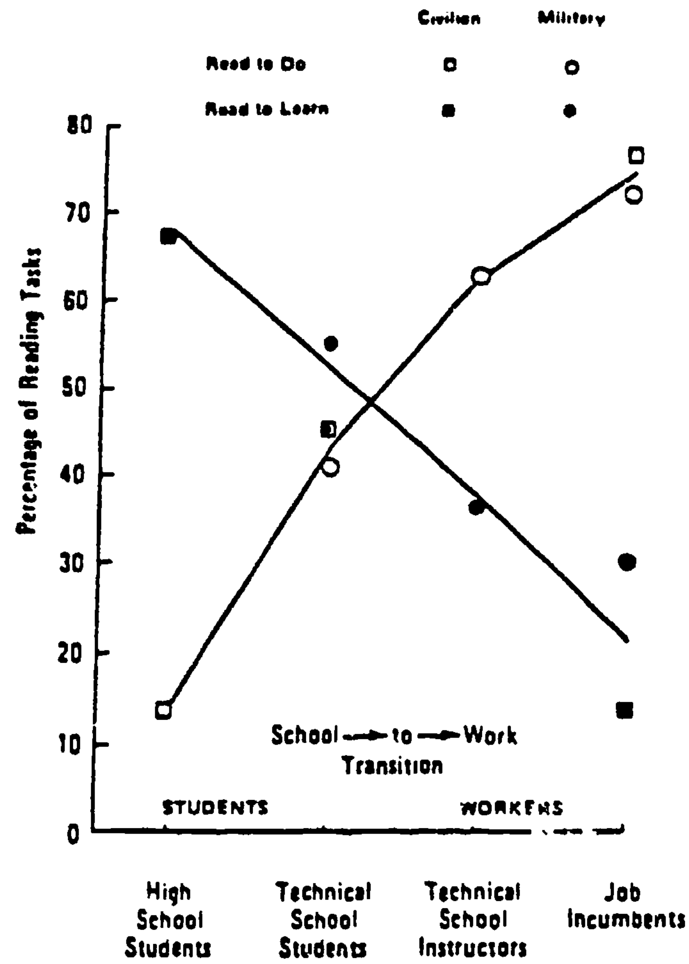


Figure 1.7
Reading Task Differences in High School, Votech, and Jobs in Civilian and Military Settings

Studies by Professor Larry Mikulecky of Indiana University in high schools and civilian jobs, and by T. Sticht in U.S. Navy technical schools and jobs reveal a shift in two primary kinds of reading tasks performed in schools and on the job. Use Figure 1.7 to fill in the following:

Figure 1.7 shows that high school students perform ______________% reading-to-learn tasks and ______________% reading-to-do tasks. On the job, however, workers reported performing only about ______________% reading-to-learn and ______________% reading-to-do tasks.

Discussion Questions: What is the difference between "reading-to-do" and "reading-to-learn" tasks? After people graduate from high school, what do you think happens to their skills in reading-to-do and reading-to-learn? Do their skills improve or decline in one or the other of these two major reading tasks? Which one(s) improve? Decline(s)?

Reading Demands of Job Materials: Readability Estimates

Study	Difficulty Levels (Reading Grade)
Moe, Rush, and Storlie 1979a-e; 1980a-e	10th-grade to college level
Diehl and Mikulecky 1980	10th- to 11th-grade average for most occupations
Mikulecky 1982*	10th- to 11th-grade average (70 percent from 9th- to 13th-grade level)
Sticht 1982	10.6- to 12th-grade plus (military manuals for varying Military Occupational Specialities or occupations)

*Workers were able to comprehend familiar work materials at one to two grade levels above their abilities to comprehend newspaper material

Figure 1.8

Difficulty of Occupational Reading Materials Using Readability Estimates

Figure 1.8 summarizes several studies of the reading difficulty of technical manuals, procedural guides, operator notebooks, training textbooks, and rules and regulations publications that workers reported reading in over a hundred job training programs and on the job. The reading difficulty levels of the materials were estimated using a variety of "readability formulas." These formulas use features of texts such as word length and sentence length to estimate the grade level in school that students would have to be in to reach a standard of performance on a reading comprehension test of 70-75% correct on the average. For the jobs studied, materials averaged at the 10th to 12th grade level of difficulty.

Readability analysis task. In this activity you will calculate the reading difficulty of samples of materials using either the hand-calculated FORCAST formula or a computer-based set of formulas, depending on the availability of computers and software. The FORCAST formula is calculated by (1) finding a sample of 150 words, (2) counting the number of one syllable words in the sample, (3) dividing the number of one syllable words in the sample by 10, (4) subtracting the result from 20 to get an estimate of the reading grade level of difficulty of the materials.

$$\text{FORCAST Reading Grade Level (RGL)} = 20 - \frac{\text{No. of 1 syllable words in a 150 word sample}}{10}$$

Discussion Questions: What are some of the factors that might limit the accuracy of readability formulas in estimating the literacy demands of school or job reading tasks? What are some other ways that one might use to estimate the literacy demands of school or job work? Are the literacy demands of training programs likely to exceed those of jobs?

Literacy and Productivity

Productivity is a concept that has many different meanings. Here, productivity is discussed in terms of how well adults with mid-level literacy (5th - 9.9th grade level) performed in several studies in the Armed Forces. "Productivity" in these studies is indicated first by how well the mid-level literates succeed in training; then how well they perform in task learning studies; and finally, how well they perform on job sample tests when they have reading materials to help them perform. The idea is that one may be considered more productive in training if he or she can learn efficiently, and on the job if he or she uses available literacy tools and more effectively performs job tasks.

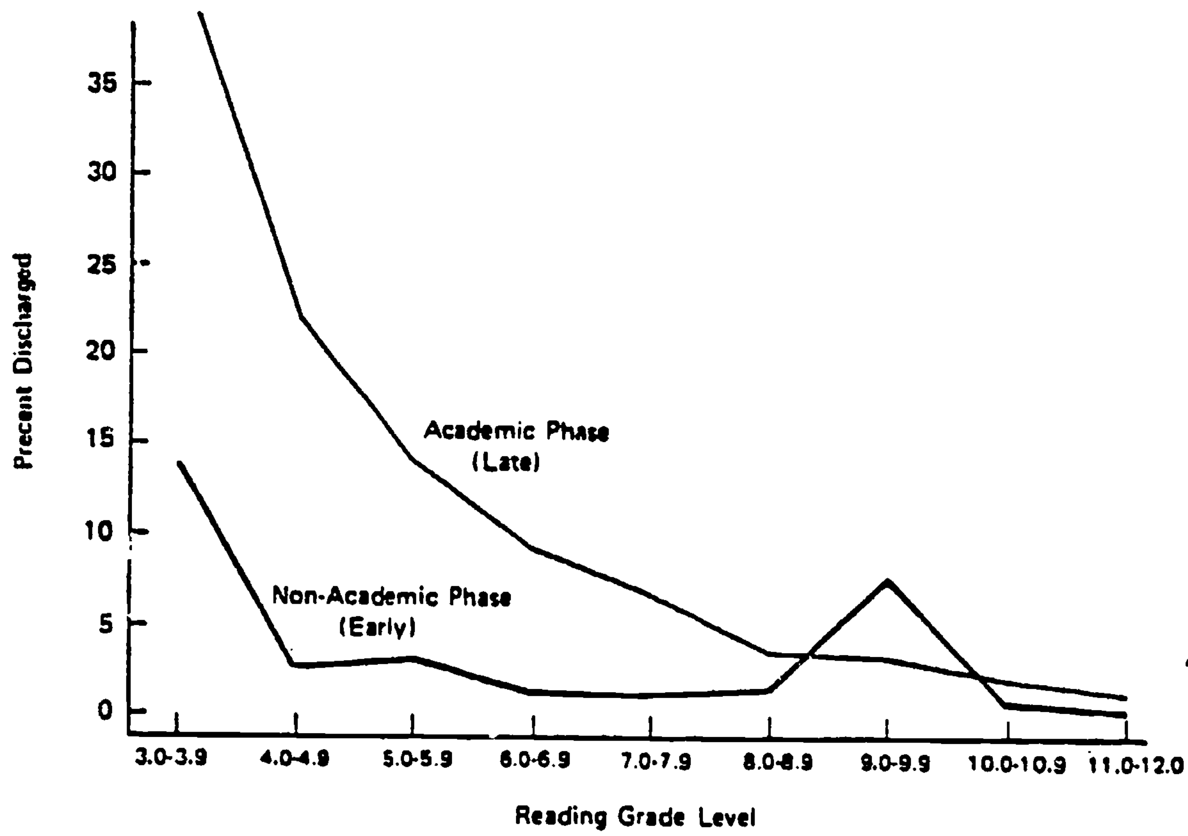


Figure 1.9

Performance in Basic Training Nonacademic and Academic Phases by Navy Recruits of Different Reading Skill Levels (from Sachar & Duffy, 1977)

Discussion Questions: Is attrition from training a useful measure of productivity? How is it that so many less literate recruits do make it through training? Are there similar relationships of literacy level and dropout rates in secondary, postsecondary, and votech schools?

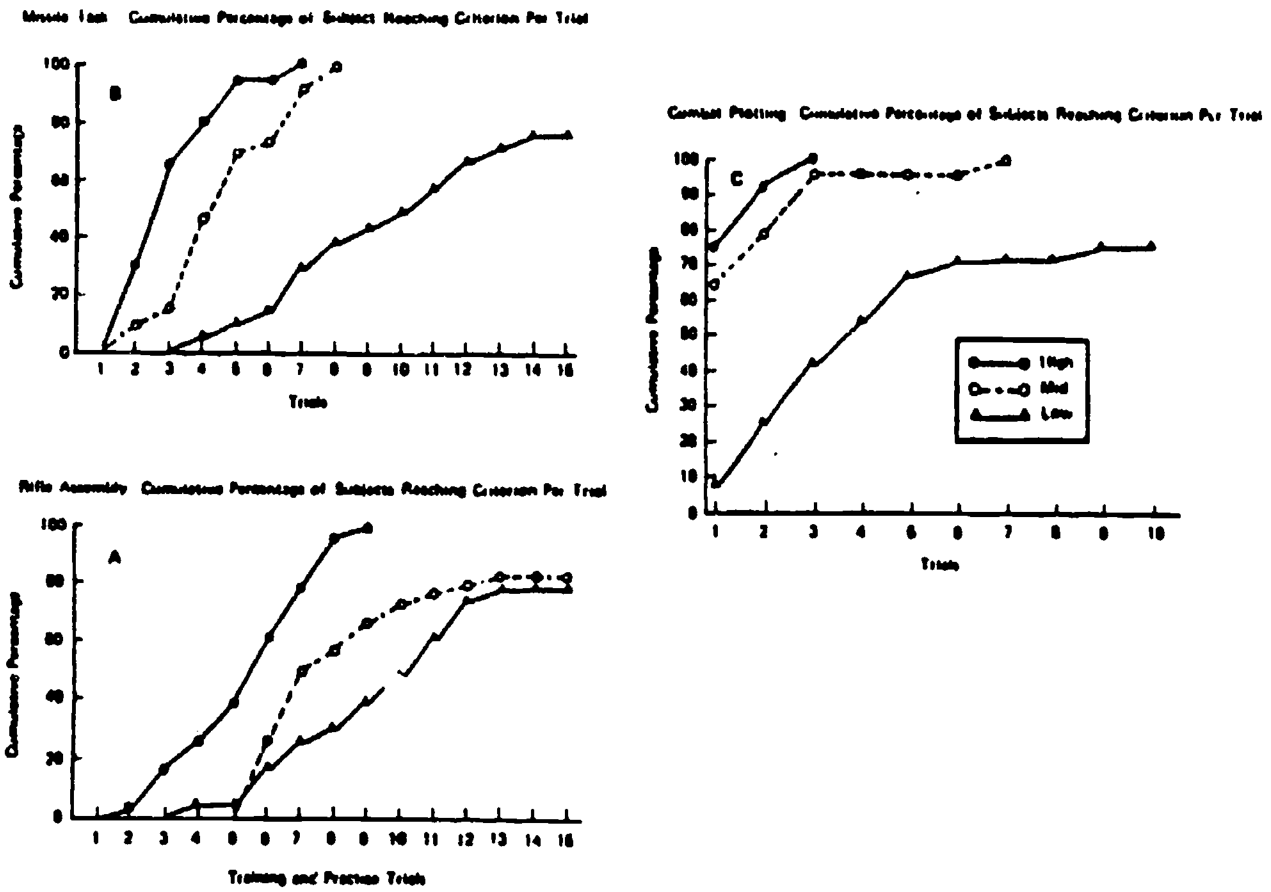


Figure 1.10

Learning of Simple and Complex Tasks
by High, Middle, and Low Literacy (AFQT) Groups

Figure 1.10 shows findings by Fox, Taylor, and Caylor in research for the U.S. Army. Three groups of men were tested on learning rifle assembly, procedural directions for operating a missile system, and using concepts of range and bearing for plotting target locations. The three groups of men were of low, medium, and high levels of basic skills as measured by the Armed Forces Qualification Test (AFQT). The data show that the low and medium skilled personnel took more trials to learn than did the high ability men. For the task involving learning conceptual knowledge, the combat plotting task, about 25% of the lowest basic skills group did not learn the task in the 10 trials given.

Discussion Questions: Is the number of trials to achieve mastery in learning a useful indicator of productivity in learning? Is there a relationship between literacy and aptitude for learning in academic or votech training programs?

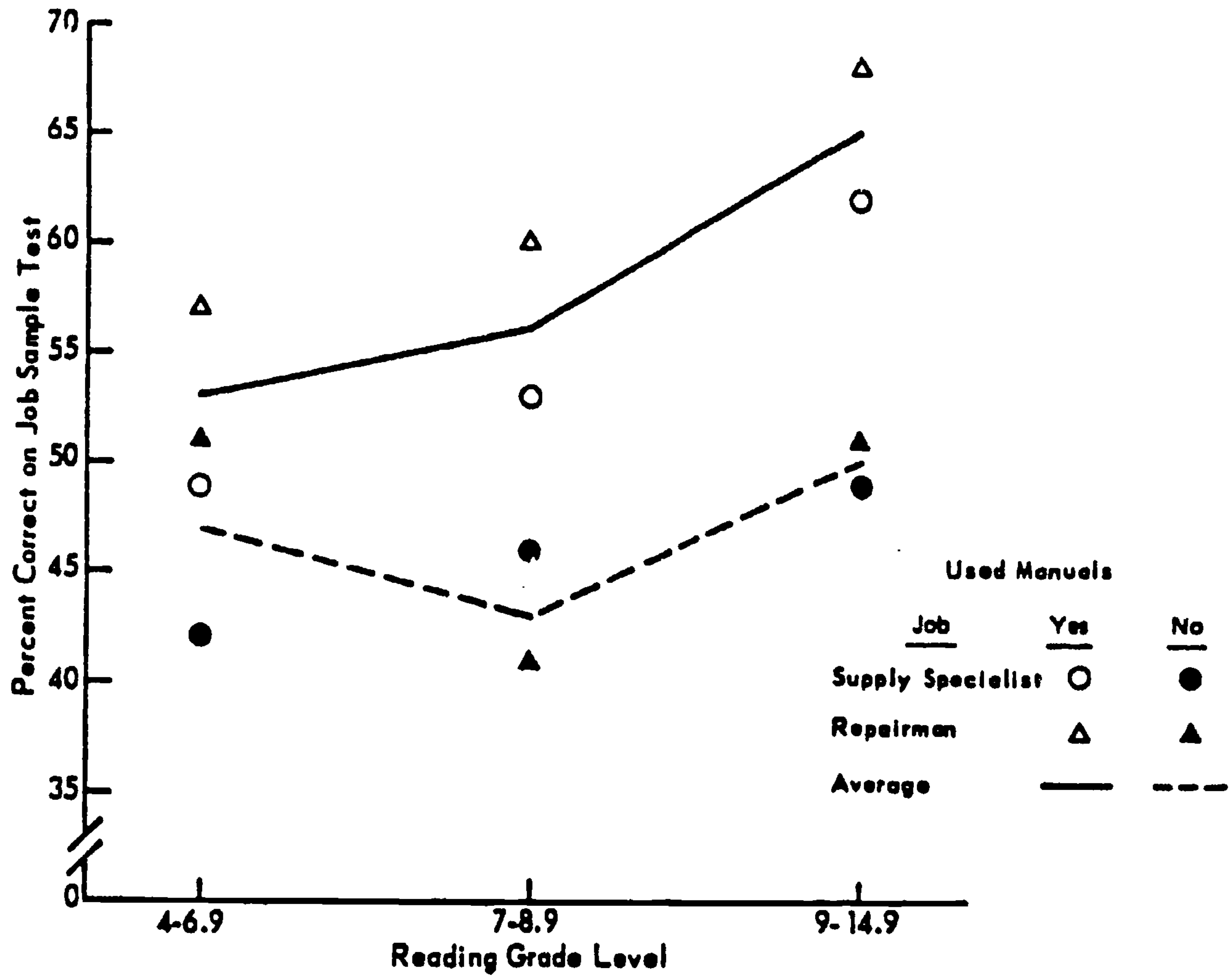


Figure 1.11

Job Sample Test Performance as a Function of Reading Ability and Use of Technical Manuals

Figure 1.11 shows that, in two U.S. Army jobs, supply specialist and automotive repairman, literacy level was not strongly related to proficiency of performance <u>unless</u> job technical manuals were used. If the manuals were used, then across literacy levels, productivity improved, and the more highly literate personnel performed better than the less literate.

Discussion Questions: Is job sample test performance a useful indicator of job productivity? Why might people, even highly literate people, avoid the use of textbooks or technical manuals at school or at work?

CHAPTER 2

FUNCTIONAL CONTEXT EDUCATION: CONCEPTS FROM THE COGNITIVE SCIENCES AND EXPERIENCE IN TRAINING "MID-LEVEL LITERATES"

In Chapter 1 we discussed literacy, employability, and productivity problems of youth and adults with reading skills between the 5th through the 9th grade levels (that is, "mid-level literates"). It was noted that, because of their relatively low literacy and learning abilities, many youth, and particularly Black and Hispanic minority youth will not qualify for academic or votech programs that are needed to gain access to the more technological jobs. Also, because females, considered as a group, have lower "technological literacy" scores than males, regardless of majority or minority status, they will be systematically excluded from the more technological education programs and the jobs to which they lead.

Because of the importance of literacy for employability and productivity, Chapter 2 will explore the nature of literacy as a cognitive ability. Scientists in fields such as linguistics, computer science, artificial intelligence, psychology, anthropology, sociology, philosophy, neuroscience, and education who study human cognitive abilities are today considered as working within the general field of "cognitive science": the study of the human abilities to sense, perceive, think, learn, and communicate. Or, stated in terms more suitable for the "information age," the human abilities to pick-up, interpret, store, retrieve, manipulate, transform, create, and communicate information.

To better understand literacy as human cognition, we will perform a series of activities that include:

(1) Taking a reading test made up of samples from several standardized reading tests and analyzing the knowledge and information processing skills called for in performing the test tasks.

(2) Based on the discussion of the first activity, a simple description of a human cognitive system will be accomplished and a series of demonstrations will be performed to illustrate components of the cognitive system and how the system processes the kinds of information making up various literacy tasks. Demonstrations will illustrate.

   (a) Sensory/perceptual processes in reading.
   (b) Working memory processes in rehearsing and recoding information to overcome the limits of working memory.
   (c) "Automaticity" in reading.
   (d) Long term memory and its "knowledge base" and the role of knowledge in the learning of and by literacy.

The FCE Workshop Reading Test

Part I: Vocabulary

Instructions: Which of the words on the right means the opposite of the word on the left? Circle your answer.

The opposite of up is	a. down	b. over	c. under	d. green
The opposite of funk is	a. sad	b. happy	c. jive	d. blue

Part II: Paragraph Comprehension

Instructions: Read the paragraph and questions and circle the correct answer to the question.

Adequate protection from the elements and environmental conditions must be provided by means of proper storage facilities, preservation, packaging, packing, or a combination of any or all of these measures. To adequately protect most items from the damaging effects of water or water-vapors, adequate preservation must be provided.

1. To protect items from water damage, one should provide

   a. humidifying
   b. adequate preservation
   c. drying chambers
   d. water vaporizers

On his melancholy days, the poet, Zadusta, lamented the missing Lila. "A pox on all of your apocalyptic steeds, you scavengers of death!"

2. In this passage, the poet cast a plague on

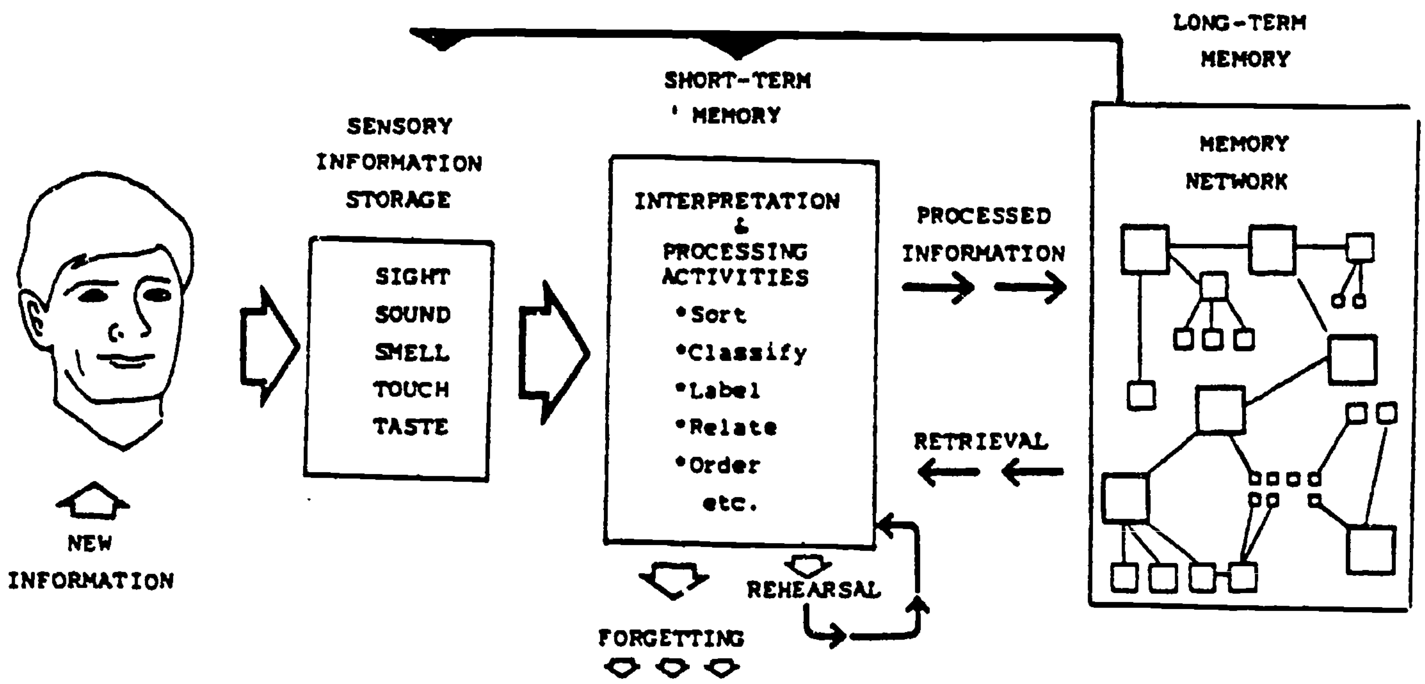
   a. a sad chorus
   b. vultures
   c. four horses
   d. a scavenger hunt

Discussion Questions: Are both the Vocabulary and Paragraph Comprehension tests measures of reading? What else, if anything, is needed to successfully answer the reading test questions in addition to reading ability? Could you answer the Paragraph Comprehension questions without reading the paragraphs? What "general literacy" skill(s) would you teach so that a student could correctly answer the question for the second paragraph?

18

THE HUMAN COGNITIVE SYSTEM

To think about the nature of literacy in a systematic way, it is useful to work from a simplified model of the major components of the mind that are involved in literacy. Figure 2.1 presents such a simplified model. Following the slide is a discussion taken from a reading instruction book developed by the U.S. Navy. We will discuss the Navy book later on in Chapter 4.



Human Information Processing

Figure 2.1

Human Cognitive System and Information Processing Model

READING AND INFORMATION PROCESSING

In this course you will learn to use a variety of skills and techniques that can improve your comprehension and recall of what you read. These skills can help you, because they take advantage of some of the things we know about "human information processing." In order to understand how these skills relate to comprehension and recall, you need to know something about how the mind processes information.

For centuries, man has been fascinated by the mystery of how his own mind works: Where do ideas come from? How do we solve problems? What makes us remember and forget? Memory has been compared to a muscle; to a tablet on which all experience is recorded; to a reference library; and more recently, to a computer which receives, processes, and stores information. The idea of memory as a series or system of processes appears to be confirmed by research over the last twenty years.

When you read the words on a page and then are able to recall the meaning of what you read at some later time, you have gone through a very complex and multi-leveled process. Scientists believe there are at least three different levels of types of information processing: sensory information storage, short term memory, and long term memory

New information comes through our senses. Sensory storage is automatic and records a "picture of the world" as yet uninterpreted by the brain. You can think of it as a picture of what you see "still in the eye" or the sound of what you hear "still in the ear." These impressions usually last less than a second and are constantly being replaced by new stimuli, as in a continuous movie.

As information moves into short-term memory, the form or structure of what is received from sensory storage is changed. The information at this level is an interpretation of the input. A few seconds after hearing someone speak, you remember the meanings of the words, not the words themselves. Short-term memory is the first level of processing where sensory information is changed to information used in thinking.

Current, but essentially temporary mental activities take place using short term memory, which is quite limited in size—usually to about seven bits of information at a time. Everything we stop thinking about disappears rapidly from this memory and is forgotten. We can, however, keep information a bit longer by repeating or rehearing it—as when you repeat a phone number to yourself until you are able to dial it.

Long term memory is where the past lives. Skills and knowledge as well as life events are recorded and stored at this level. Long term memory is the most powerful, complex, and least understood of the processing systems. Its capacity is huge. One scientist has estimated that during an average lifetime, we accumulate something close to 500 times as much information as there is in a set of encyclopedias! Given the huge amount of information, how is it that we are able to find specific bits of data in our long term memory?

At present, there is no absolute answer, but it is believed that information is grouped in categories or chunks in an elaborate network or web-like structure. To move information from short term to long term memory involves processing which transforms the data so it can be linked to the existing network. The mind is then able to retrieve information by making use of the links or paths in the long term memory network. An example of this can be seen with what happens to information when we try to learn by "cramming" for a test. We struggle to memorize and retain the material long enough to take the test, but frequently forget much of it once the test is over. On the other hand, if we use the same material to write a report or make a presentation, we are using processes which help to "knit" the new data into the long-term web and make it a part of memory. The skills and learning strategies presented in this course make use of some of these processing elements applied to reading tasks.

ERIC

NOTES FOR DEMONSTRATIONS

Sensory/Perceptual Processes

Demo #1: Decay time of sensory information store: moving pencil.

Demo #2: Subitizing: Dots on paper.

Working Memory (Short Term Memory)

Demo #3: Limits of working memory/role of rehearsal and recoding in overcoming limits. Memory for numbers and sentences.

Demo #4: Automatization of processing to overcome working memory limitations. The Stroop Test.

Demo #5: Literacy as use of graphic tools for overcoming limitations of working memory. Solving the disease problem.

Long Term Memory (The Knowledge Base)

Demo #6: Organization in the knowledge base: word associations.

Demo #7: Knowledge in long term memory and effects on comprehension: doodles.

Demo #8: Prior knowledge and reading comprehension: The Bransford Passage.

ERIC

Developmental Model of Literacy and Intergenerational Transfer of Literacy

The preceding demonstrations and discussion emphasized the major components of a human cognitive system and how it processes information, including written language and other graphic displays. The role of prior knowledge in information processing and reading comprehension was noted. Because of the importance of knowledge in both learning and applying literacy skills, it is necessary to think about how people change from being born illiterate, to being literate. This means that we need to consider how children develop cognitive abilities from birth through adulthood. This developmental perspective on literacy and other cognitive abilities will help in understanding how the more highly educated parents transfer the prior knowledge their children need to become the more literate citizens of the next generation. In turn, this is an important basis for emphasizing the importance of adult literacy development.

A DEVELOPMENTAL MODEL OF LITERACY

Developing cost-effective literacy and human resources development systems in work settings requires formulating some concept of literacy that can serve as a heuristic device in the planning, conduct, interpretation, and synthesis of research. For these purposes, I have found it useful, in conducting research and development projects on the nature and use of literacy skills at work, to follow a macromodel of the major components and processes involved in developing such skills.

Figure 2.2 presents, in schematic form, an overview of the major concepts included in the developmental model of literacy. Before addressing the details of the model, several orienting comments regarding Figure 2.2 are in order. First, the figure is meant to portray a developmental sequence when examined from left to right. The sequence begins with the newborn infant, and goes through stage 4 in which literacy skills are functional. The broad arrowhead on the far right is meant to imply continued development over the lifespan. The development of literacy, language, and knowledge is a lifetime activity.

Examining Figure 2.2 from top to bottom, the top series of boxes is meant to represent the environment in which the person exists. This is the environment "outside the head." This external environment makes available information displays in the form of structured energy (mechanical for hearing; electromagnetic for seeing) that the person can explore and transform into internal representations of the external information. These internal representations are developed by the processes in the second series of boxes labeled, on the far left, Information Processes in Working Memory. These processes go on "inside the head," and merge information picked up from the external information displays with information picked up from the third series of boxes, labeled on the far left as Long Term Memory. Thus, the processes in the working memory are used to pick up and merge information from outside the brain with information in long term memory inside the brain to construct an internal representation of the world at a given time.

At the top of Figure 2.2 there are references to four stages. Stage one refers to the newborn infant who is considered to be innately endowed with the Basic Adaptive Processes involved in sensory/perceptual processes such as hearing and seeing, etc., motor movement, and cognition, including the processes needed to acquire information, mentally manipulate it, store it in memory, form knowledge structures out of it (e.g., images, facts, concepts, principles, rules, and after considerable education, large structures of subject matter areas such as mathematics, biology, etc.) and retrieve and represent the information in various ways. In stage 1, these processes are assumed to work more or less automatically without conscious control.

Stage 2 represents the emergence of conscious control over information pick-up and manipulation. This active process of attending to information distinguishes listening from hearing, and looking from seeing, as information pick-up processes. Listening and looking build internal representations that may be called images (though at times this general term is divided into echoic and iconic images for listening and looking, respectively). Images may also be constructed from data stored in long term memory. These internal imaging

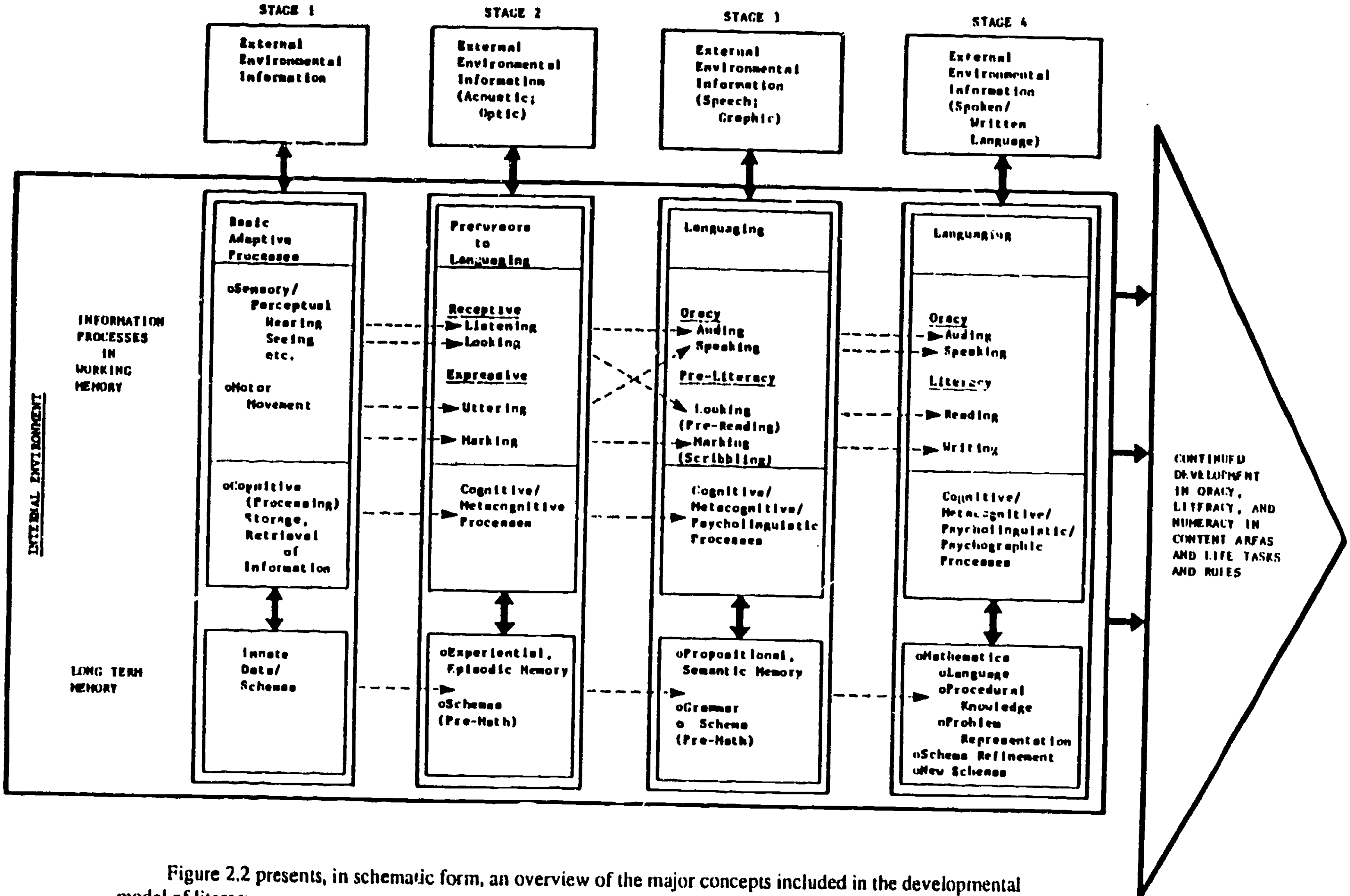


Figure 2.2 presents, in schematic form, an overview of the major concepts included in the developmental model of literacy.

BEST COPY AVAILABLE

processes are frequently assessed in aptitude tests as "spatial perception" or "mechanical comprehension" in which it is necessary to mentally visualize and rotate cog and gear assembles to determine what effect this movement might have on some other gear.

Stage 2 also introduces the concept of active or working memory, which is defined by the occurrence of consciously controlled information processing activities. Working memory is a limited memory that can easily be overloaded (e.g., attending to two or three things at once is difficult—if not impossible). Many of the information processing activities the person acquires will be techniques to overcome active memory limits (e.g., repeating information to oneself keeps the information in active working memory until it can be applied).

Stage 3 represents the development of language processes out of earlier processes and knowledge stored in long term memory. In developing oral language, the listening process is used in attending to spoken language to learn the words and grammar of language. Thus, listening plus languaging, occurs simultaneously. This joint occurrence is given the special name of auding. On the production side, the joint occurrence of uttering (making sounds through the mouth) with the production of word forms from the language pool, and stringing the word forms together to make sentences using the rules of grammar, produces the special process called speaking. Auding and speaking comprise the oral language information reception and production skills. Speaking is used to represent information that the person has in his or her mind "outside the head" and in the acoustic medium, while auding is used to pick-up and decode speech information displays into knowledge in the mind of the listener.

In stage 4, the information processing skills of looking and marking are used to learn a representational system which, in many respects, represents the spoken language in a different medium—light—and in a more or less permanent graphic display: the written language. Looking at written language and transforming the written language into meaning is called reading. Writing is the special use of marking skills to produce graphic language (and other symbols and symbol systems).

In the typical case, people develop a fair amount of competence in oral language before they are exposed to formal instruction in reading in the elementary grades. The written language skills build upon the earlier developed oral language skills and add new vocabulary and concepts, as well as special knowledge about how to represent information in the graphic medium, to the person's knowledge base. In turn, learning new vocabulary and conventions of language through reading and writing enlarges the person's oral language abilities. The large arrow at the far right in Figure 2.2 is meant to represent the notion that the development of oral and written language ability may continue indefinitely. As mentioned earlier, learning to read can take a lifetime.

A major component of Figure 2.2 is the person's long term memory. The long term memory contains all the knowledge developed by the person in interaction with the environment, including the processes the brain invents to overcome limitations in working memory and other aspects of its functionings (such as retrieval processes for remembering information). Much of the knowledge acquired by the person will not be understood in consciousness (for example, the rules of grammar). Rather, it will be unconsciously used to accomplish tasks such as developing language competency and comprehending the events of the world. In addition to the general world knowledge and processes that are in the mind, though not accessible to conscious understanding without considerable analysis, the memory also contains the language knowledge (words and grammar) that can be used to represent information that arises from experience in the world (e.g., bodies of knowledge about parts of the body, houses, neighborhoods—sometimes called "schema" in cognitive science terms (Rumelhart, 1980) and from didactic instruction, as in training programs.

The model holds that the development of the oracy skills of speaking and auding is built upon the development of the prelinguistic cognitive content through intellectual activity which I call conceptualizing ability. It is important that it be understood that this early, prelinguistic cognitive content, or knowledge, will form the foundation for the acquisition of new knowledge over the person's lifetime.

ERIC

Much of this knowledge will remain personal, and will not be explicitly represented in language for communication to others. Nonetheless, such personal, tacit knowledge, which includes perceptual learnings and general knowledge of "how the world works," will be absolutely necessary for learning to comprehend the spoken, and later the written, language. This reflects the fact that language is selective in the features and concepts chosen to be represented. We may think of language as producing a verbal figure, which can be comprehended only in terms of its relationship to a nonlinguistic conceptual ground of "world knowledge." A simple illustration of the role of personal or "world knowledge" in literacy training is seen in the recommendation to give students experience with objects and events in the world through field trips, demonstrations, movies, etc. before they read about them. This approach provides an experiential base or "world knowledge" which will permit a deeper comprehension of the words and concepts the students read.

A final aspect of the model is that it recognizes that, on the one hand, the literacy skills of reading and writing utilize the same cognitive content used in auding and speaking, plus the special decoding and encoding skills of reading and writing. On the other hand, the very nature of the written language display—characterized by being more or less permanent, being arrayed in space, and utilizing the features of light (color, contrast)—makes possible the development of skill and knowledge entirely different from that involved in oral language.

The model incorporates the role of prelinguistic looking and marking abilities as contributors to later utilization of the visual display of written language in conjunction with lines, white space, and color to develop graphic tools such as matrices, flow charts, color coded graphs, and the like. These tools combine with written language and non-language graphic symbols, such as arrowheads and geometric figures, to produce analytical products beyond those obtainable through the fleeting, temporal oral language.

The point to be emphasized is the fact that much of the acquisition of literacy is not simply learning to read; that is, it is not just learning a language system that can be substituted for the oral language system. Rather, a large part of learning to be literate, and perhaps the most important part for acquiring higher levels of literacy, is learning how to perform the many tasks made possible by the unique characteristics of printed displays—their permanence, spatiality, and use of light—and using this knowledge to acquire extensive bodies of other knowledge.

THE INTERGENERATIONAL TRANSFER OF LITERACY

The relationship between oral and written languages discussed in the developmental model has implications for policy on adult and childhood intervention programs aimed at breaking cyclical patterns of low educational achievement and low economic achievement. In this cycle many students who enter our public schools come from homes in which they have been unable to acquire the minimal competencies needed to succeed in school; many of these students become dropouts and academic failures of the school system; they then become the unemployed or underemployed, lower socioeconomic status, marginally literate parents of a new generation of students who, in their turn, will enter the schools without the minimum competencies needed to succeed, and the cycle of marginal literacy and marginal living will repeat itself.

Current attempts to interrupt this cycle focus resources in compensatory programs operated in the public schools, where it is hoped that the disadvantages of the home can be overcome by extra effort in the classroom. While the expenditure of billions of dollars in such compensatory efforts has perhaps made some improvements in elementary grade achievement (Beller, 1973), the effects have not been as dramatic as the differences among children when they show up for the first grade. Furthermore, the effects seem to diminish by the middle grades (Bronfenbrenner, 1975, p. 592).

At least one major reason for the limited effectiveness of national policies to improve the educational achievement and subsequent employability of children from marginally literate homes is that they do not

recognize the role of the education of the parent in the education of the child. Repeatedly, studies show that low-level oral and written language skills of the parent are recapitulated in the skills of the children—even before these children begin schooling.

The interrelationships of parents' and childrens' educational achievement are evident in data from the National Assessment of Educational Progress (NAEP). Figure 1.4, Chapter 1 shows how young adults whose parents had no high school, had some high school, were high school graduates, or had post-high school education performed on a variety of literacy tasks. Clearly the parents' educational achievement was strongly related to the subsequent achievement of literacy by the children. This holds true over the 25 years spanned by the birth dates of the adults, a period in which most of the preschool and elementary school intervention programs were initiated and carried out in our nation.

While drawing straightforward conclusions from data like those presented in Figue 1.4 is always risky, because of unknown factors such as possible differences in native abilities between parental education groups, other data indicate that less well-educated adults do not perform reading tasks as well as better educated adults (Harris and Associates, 1970; Golden and Birns, 1976). Adult poor readers are also likely to have low oral language vocabulary skills and have difficulty comprehending orally presented passages (Sticht, 1982). It seems reasonable to suppose that such adults will be unable to promote extensive vocabulary development in their preschool children, or to provide them with opportunities to listen to orallv read stories to develop passage comprehension abilities. It is well documented that less educated homes offer fewer opportunities for the preschool child to observe role models performing reading tasks and to listen to extended, elaborated spoken discourse like that encountered in the schools (Hess & Holloway, 1979).

In other words, such children are less likely to listen to "literate" speech than children from homes where highly literate parents "speak print" to a large degree, and where the parent reads, goes to the library, and in general, makes a great deal of functional use of the written language. We can suppose that by all these mechanisms the more literate parents transfer aspects of literacy to their children, and that such transfer is lacking in the homes of the less well-educated parents.

Oracy to Literacy Developmental Sequence

If children come to school with poorly developed oral language skills and knowledges, the chances are that they will have a difficult time acquiring good written language skills. This reflects the role that oral language plays in reading. A recent review of the relationships between oral and written language has revealed that, despite the continuing debate over which "approach" to reading is best, there is agreement among the three major positions—code, meaning, and psycholinguistic—as to the importance of oral language to the development of reading skills (Sticht and James, 1984). All three positions share the fundamental understandings that, typically:

(1) Oral language skills develop to a fairly high level before the development of written language skills.

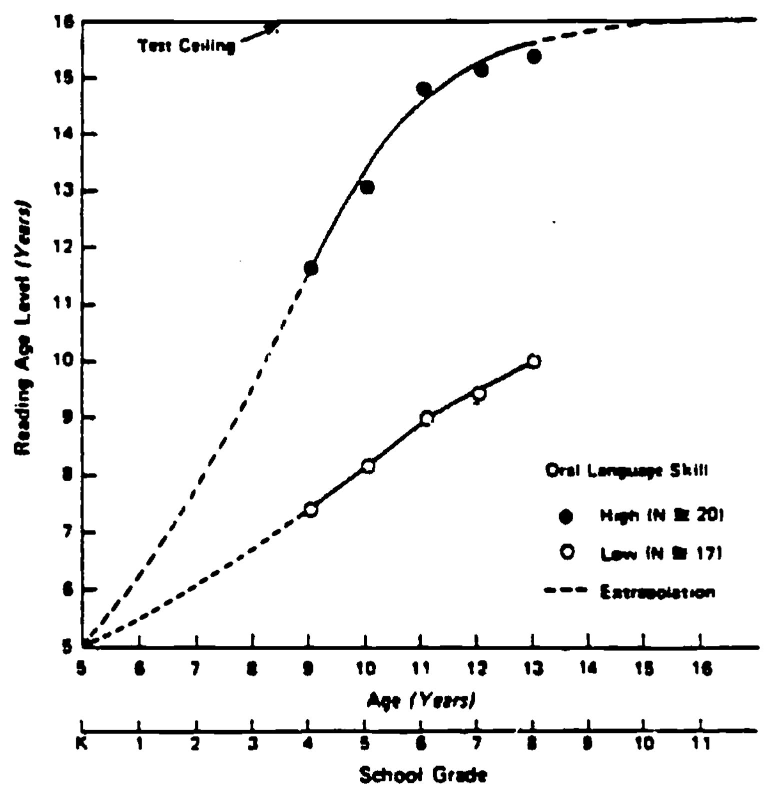
(2) Oral and written languages share much of the same lexicon (vocabulary) and syntax.

(3) Beginning readers draw upon their knowledge of oral language in learning to read.

Loban's (1964) longitudinal studies present the clearest picture of the relationships of early skills in oral language to later skill in reading. Loban measured preschool children's oracy (listening, speaking) skills and identified two groups, those high in oracy skills and those low in such skills. He tracked them in the school system and measured their reading skills beginning in the fourth grade. As shown in Figure 2.3, students low in oral language skills before the first grade turned out to be the poor readers in the fourth grade and onward through the eighth grade, and the gap between good and poor oral language users on the performance of written language tasks grew wider over the school years.

Other data reviewed by Sticht et al. (1974) clearly show that the development of written language skills is greatly facilitated by the development of high levels of oral language skills. In fact, for many purposes, learning to read may be viewed as learning to be as efficient in performing tasks involving written language as one is in performing tasks involving spoken language. The review by Sticht et al. indicates that, when children first enter school, they can comprehend spoken messages and remember the information much better than they can if the same messages are presented in the written language for reading. By about the sixth to eighth grades, however, people are likely to do as well by reading as they can by listening, indicating that they have closed the gap between comprehending by ear and by eye.

Because learning to read includes learning to comprehend by reading as well as one can by listening, it follows that if children could learn to comprehend better by listening to spoken language, then when the reading skill is developed to the point of parity between ear and eye, the child would be reading on a higher level. In this case, the child's ability to comprehend the spoken language can be regarded as an indicator of the potential for that child's reading achievement if he or she could instantly be given the power to decode and comprehend the written language.



NOTE: Figure constructed from data given in Loban, 1964, page 117, Table 15

Figure 2.3

Relationship Between Chronological Age/School Grade Level and Median Reading Ability for Students Rated High or Low in Oral Language Skills in Kindergarten

Youth and Adult Literacy Development

By now, the direction I am heading will have become apparent. If the child's preschool language development is strongly dependent upon the parent's literacy and oracy skills, and if the child's literacy skill development in school is largely dependent on the child's oracy skills developed prior to schooling, then a major approach to improving children's literacy skills is to improve their parents' language skills, both oral and written.

In this way of thinking, youth and adult literacy development should be a high-priority program for education policymakers not only because so many adults are living in marginal circumstances and have only marginal literacy skills to cope with our high-information density culture, but also because the parents' educational achievement can be transferred to their children. In other words, to complement our intervention programs that give funds to the schools to mediate between the society at large and the children from marginally literate homes to improve those children's basic literacy skills, we can imagine a program in which children's literacy skills are mediated before the school days through extended opportunities for educational development of adults/parents.

I have underlined the word extended to draw attention to the fact that in proposing adult education as a major method of improving children's educational achievement, I do not refer to the typical current adult (youth) basic education programs. Such programs are totally inadequate to improve adult competencies enough to offer much by way of transfer to the children, or, for that matter, to do much for the future life of the adults who participate in them (cf. the chapters on adult literacy training in the volume edited by Carroll and Chall, 1975). Most adult basic education programs attract and hold adult clients for only about 50 to 100 hours of literacy development. They typically make only about one to two grade levels of improvement in that period of time, and even that much gain is suspect in terms of subsequent retention of skill. For the six percent or so of the high school graduates who leave high school reading below the seventh grade level (Fisher, 1978, p. 37), a year's gain hardly suffices to make a difference in living style or in manner of speaking and interacting with one's children at the oral language level.

What is needed is a commitment to pursue, with as much vigor and funding as in the current school-based intervention programs for children, a program of adult literacy development that regards such development as a perfectly appropriate activity for a nation. In such an approach, the development (not remediation!) of adult capabilities would be considered as important a task as children's development.

THE NEED FOR FUNCTIONAL CONTEXT EDUCATION: THE ADULT'S CONTEXT

The following extract reviews research within the military that indicates (1) problems with most adult literacy programs; (2) why it is often believed that brief literacy programs can make fast, major increases in adult's literacy levels; (3) why this belief is incorrect; and (4) why programs that take account of the functional context in which the adult exists may make more rapid learning of specific knowledge and processing skills possible. This will serve as an introduction to Chapter 3, in which the Functional Literacy programs developed by the U.S. Army in the early '70's are discussed.

Problems With Brief, Concentrated Basic Skills Programs

A major feature of most adult literacy programs conducted by the military and human resources development programs in industry, job skills upgrading and similar organizational settings, is their brevity. In the military, remedial literacy programs are typically three to six weeks or so in duration, and permit some 100

to 200 hours of instruction. The brevity of such programs appears to be based, at least in part, on the often held belief that marginally literate adults can learn to read more quickly than can children: "Adults have better visual perception than children, larger speaking and listening vocabularies than children . . . . Such people coming to class with a new motivation for reading can learn very quickly, especially if they can see the logic of what they are doing—that is, if they see a logical sequence in the program, if they grasp the concept of spelling and sound, if they are confronted with reasonable and psychologically appropriate problems." (Mary C. Wallace: Literacy Instructor's Handbook, 1965, p. 74).

The belief that adult literacy students can learn more rapidly than children in the elementary school system is often supported by data showing that adult literacy students in a particular program made one, two, or even more years of gain in reading in as few as 14, or 50, or 100 or so hours of instruction (Sticht, 1982). Thus, what the typical child in the public school system requires up to two years to learn, the adult illiterate is said to learn in just a few hours. How can this be so?

Rather than suspecting the psychometric tests by which improvement in reading is assessed in adult basic skills programs, in which in most cases a year or two of "learning" can be achieved simply by answering three to five more items correctly, the assumption seems to be made by adult educators that if adult literacy students score at a given grade level on a basic skills test, then the adult student is probably just as proficient, or more so, in that skill as the student in the grade school who scores the same as the adult does. Thus, if an adult literacy student scores on a reading test at the fifth grade level, the assumption may be made that the adult can now perform fifth grade literacy tasks as effectively and efficiently as can a typical fifth grade child.

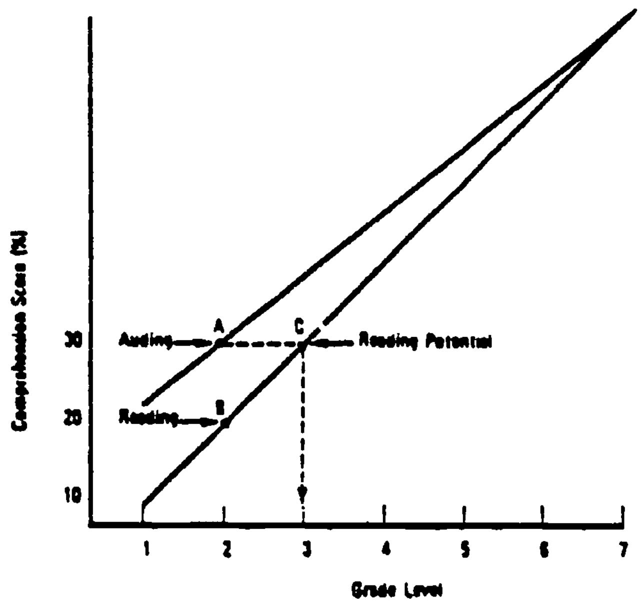
The "Reading Potential" Concept. The belief that adult marginal literates can make rapid increases in literacy in brief remedial programs appears to be based, at least in part, on the idea that adults have had more experience than grade school children, they have had more opportunity to acquire concepts through oral language and thus they can be expected to have a larger oral vocabulary and to be able to comprehend information presented in the spoken language more effectively than can a child. This presumed higher capability of marginal literates in oral language over grade school children provides a higher "reading potential," so it may be argued, and hence, it is possible for adult marginal literates to make more rapid increases in learning to read as they close the "gap" between what they can already comprehend in oral language and what they can comprehend in the written language.

The reading potential concept mentioned above is central to the understanding being explored here as to why it is believed that marginally literate adults can make rapid progress in literacy programs of short duration. Briefly, the reading potential concept states that, in the typical case, people first develop vocabulary and comprehension skills by means of the oral language skills of auding[1] and speaking. Then, when they begin to learn to read, they learn to comprehend by reading what they previously could comprehend only by auding. Stated otherwise, in the typical case of the person who is learning to read, he or she will begin training with a relatively large capability of comprehending the spoken language. In learning to read, then, one of the person's major tasks is to learn to comprehend the printed form of language with the same accuracy and efficiency as he or she comprehends the spoken form of language.

Because people typically learn to comprehend language by auding before they can comprehend it by reading, it is possible to consider that, in learning to read, they close the "gap" between the auding and reading skills, both of which permit them to comprehend linguistic message displays. This process is illustrated in Figure 2.4, where it is seen that, at the beginning of schooling, people can comprehend language better by auding than by reading. As they progress through the school grades, they acquire more and more skill in reading, and eventually close the gap between auding and reading skills.

---

1 Auding is a word coined by Brown (1954) to name the special kind of listening we do when we listen to speech. Just as reading is a special kind of looking, i.e., looking at printed language to get meaning, auding is a special kind of listening: listening to spoken language to get meaning.



A – Indicates the normative auding score for the 2nd grade, called auding at the 2nd grade level.

B – Shows the normative reading score for the 2nd grade, called the 2nd grade level.

C – Shows conversion of the normative auding score to a reading "potential" score by drawing a horizontal from A to intersect with the reading curve, and then dropping a perpendicular line to the abscissa.

The example shows a reading potential score of 3rd grade.

Thus, the case illustrated shows a person auding and reading at the 2nd grade level, with a reading potential score of 3rd grade level.

Figure 2.4

Schemata Showing Relationships Among Auding and Reading Comprehension Scores as a Function of School Grade Level

In the reading potential concept, a person's capabilities in auding are considered to establish a potential for reading. In Figure 2.4, the auding curve represents, at each grade level, the level to which reading skill would arise if, by some magical process, the person could be instantly taught reading decoding skills. Thus, if a person was very unskilled in auding, his or her reading potential would be said to be low, being limited by poorly developed oral language skills. On the other hand, persons highly skilled in auding would have the potential to become highly skilled in reading, and in a relatively brief time, because reading comprehension would be limited mostly by the fairly simple to learn decoding skills rather than by the more difficult to teach and to learn language comprehension skills and knowledge (vocabulary; concepts).

Figure 2.5 contrasts the reading potential concept as it might be assumed for children versus marginally literate adults. In the hypothetical case illustrated in Figure 2.5, a child who reads at the second grade level has a slightly higher auding score that translates to a reading potential score of third grade. The top dotted line illustrates the auding score as it might be assumed by teachers in an adult basic skills program. For an adult student scoring on a reading test at the second grade level, a fairly high level of skill in oral language comprehension is assumed, which in the case illustrated translates into a grade 6.5 reading potential level. Thus, the adult reading at the second grade level is thought to have over four times the reading potential (6.5-2=4.5 grades of reading potential) of the second grade student (3-2=1 grade of reading potential).

The foregoing concepts of reading potential appear to underpin, at least partially, the more-or-less common sense belief that adult literacy students can acquire basic skills more rapidly than children in schools. It is thought that the adults' higher oral language skills and world experience gives them higher "reading potential" than elementary school children (Figure 2.5). In turn, this belief is reinforced through the use of

grade school referenced standardized tests that report gain in grade levels. Thus, when it is demonstrated that adults in a brief, concentrated program make one or two years gain in reading, this may be interpreted to mean that the adults learned as much in a few hours as children do both in and out of school in one or two years:

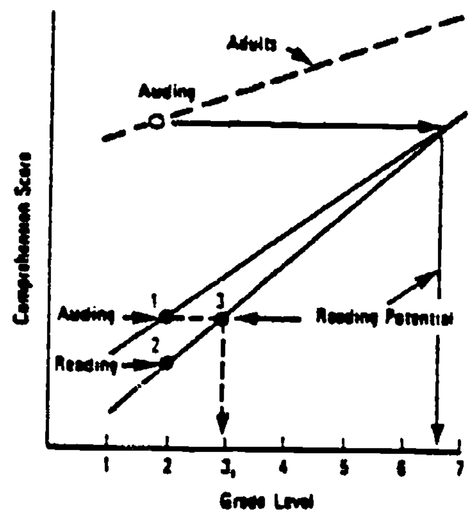


Figure 2.5

Comparison of the Reading Potential Concept Applied to Marginally Literate Adults and to School Children

"Adult learners, on an average, do progress faster than children if we can take the reading tests at face value." (Ryan and Furlong, 1975, p. 178).

Research Comparing Children and Adult Basic Skills Students on Reading Potential

Because of the centrality of the reading potential of marginally literate adults to the conduct and evaluation of adult basic skills programs in the Army, research was conducted (Sticht, 1982) to compare the reading potential of children and Army literacy students empirically, so that one might know whether or not one should take the reading tests at face value when applied to adults.

Three studies were conducted to determine if (1) adult literacy students have greater reading potential than school children who score at comparable levels to the adults on standardized reading tests, and (2) adult literary students are more efficient learners than such children. These studies are described in detail in Sticht (1982). Briefly summarized, these studies, which used Army personnel who were enrolled in an experimental basic skills education program, showed that:

- Marginally literate men (MLM) reading at the fifth grade level on a standardized reading test performed comparably to typical fourth and fifth grade students on tests of comprehension by auding and reading when the materials were presented at 128 wpm. Thus, the oral language skills of the MLM did not exceed those of the children.

• Marginally literate adult men reading near the fifth grade level performed more poorly than typical fifth grade students on tests of learning from audio-visual materials presented for simultaneous auding and reading at rates of 228 and 328 wpm.

• Marginally literate adult men showed approximately 0.5 to 1.0 years of reading potential when administered an auding and reading test that was standardized and normed on children in the grade schools. Actual reading scores were at the 5.0 level while reading potential scores were in the upper fifth and lower sixth grade range.

• Marginally literate adult men in a military job-related reading program of six weeks duration showed a median gain of 0.7 grade levels in general reading and 1.6 grade levels in job-related reading of the type being taught in the program. There was no relationship of reading potential to gain regardless of the students' entering reading skill levels. These studies, though limited in number and types of adult literacy students and grade school children involved, suggest:

• One should not take the reading tests based on children in the school grades at face value when applied to adult literacy students. Adult literacy students who scored at the fifth grade level on a standardized reading test normed on children were not as effective and efficient processors of oral and written language as were typical fifth grade children like those on whom the reading tests were normed.

• One should not assume that adult literacy students have greater "reading potential" than do grade school children who are at the grade level that adults score at on standardized tests. Marginally literate adults reading at the 5.0 level had auding scores that were also at the fifth grade level which, when converted to reading potential scores fell at the sixth grade level. This is far short of the tenth grade level, which represented the years of education completed by 80% of the students.

• One should not expect rapid, large increments in basic literacy skills of adult literacy students in brief, concentrated programs of general literacy. Such programs require that adult students have a fairly high level of oral language skills for large gains to be rapidly made in general literacy.

However, marginally literate adults in a job-related reading program made twice the gain in job-related reading than they did in general reading, suggesting that more rapid learning of particular types of reading will occur when training is specifically focused on that type of reading rather than on "general" literacy. Hence, if adult literacy students need to read "functional" materials more than academic textbooks, it would seem more efficient to provide direct practice in reading functional materials than in reading "college prep" materials. The reading grade levels of most standardized tests are derived from school children using academically-oriented texts and exercises that require highly developed language and analytic reasoning skills for successful execution. Such skills, applicable in a wide-range of situations, would seem to be difficult for adult literacy students to develop in brief, concentrated programs.

CHAPTER 3

FCE CASE STUDY #1: LITERACY PROGRAMS FOR COOK, AUTOMOTIVE REPAIR, COMMUNICATION, MEDICAL, AND SUPPLY CLERK WORKERS

From the developmental model of literacy, we know that for someone to be able to read and comprehend in a given content area, they must have some prior knowledge about what they are reading. Also, to develop large amounts of knowledge, a considerable amount of time is required. We give children 12 years to acquire high school levels of knowledge and skill.

If adult students need to learn a job, and they have only a limited amount of time to learn it in—because they need to get out of school as fast as possible to start earning a living, or they are in a time-based system, such as the public schools, military training "pipeline," or community college semester—then it seems more reasonable to give them literacy training in the job field that they wish to enter than to put them into a GED-oriented, academic program where they may study the interpretation of Keats, when they need to learn to count sheets!

In Chapter 2, it was noted that it is possible to develop a fair amount of competence in a limited domain of knowledge in relatively brief periods of time. That conclusion was based on work sponsored by the U.S. Army that resulted in the development of JOB-RELATED READING PROGRAMS for personnel assigned to become Cooks, Automobile Repairmen, Communications specialists, Medical Corpsmen, and Supply Clerks. In Project FLIT (Functional Literacy), the role of prior knowledge in reading comprehension was recognized by teaching reading of job-related materials to personnel just before they entered job technical training. This provided (1) information processing skills for locating and extracting information from manuals and forms to perform reading-to-do tasks, and (2) job content knowledge to improve comprehension and reading-to-learn in their job training programs. The following extracts summarize some of the development activities, products, and outcomes of the FLIT project.

Occupational Literacy Training in the U.S. Department of Defense: The FLIT Program

This section discusses projects that (1) identify the minimum competency levels needed to perform reading tasks successfully in several jobs within the United States Army and (2) develop a job-related functional literacy program to bring marginally literate readers up to the minimum competency level established for the Army in the preceding research. Complete descriptions of the research and development can be found in Sticht (1975a, 1975b).

Identifying Minimum Competency Levels for Job-related Reading

To determine the literacy requirements of Army jobs, three different approaches were used. In these three approaches, the reading requirement of a job was established in terms of one of the following:

- Direct measures of job knowledge and job performance.
- The readability (reading difficulty level) of the Army manuals prescribed for use in learning and in doing the job.

- The specific job reading tasks inherent in performing the job.

Each of these approaches is described here.

Job proficiency. The first approach to determining the literacy demands of jobs was to examine the relationship between the general reading ability level of job incumbents and their job proficiency. Job proficiency was measured both by a written test of job knowledge and by an extensive hands-on sample of job performance. For each of four Military Occupational Specialties (MOS's), the literacy requirement of the job was estimated as the lowest reading grade level at which no more than a chance proportion of men fell in the bottom quartile on the job proficiency measures. These analyses indicated a consistent relationship between literacy and job proficiency and suggested the requirement of seventh grade reading level for cooks, eighth grade reading level minimal requirement for armor crewmen and vehicle repairmen, and ninth grade reading level for the supply clerk's job.

This approach to establishing the reading requirements of jobs has the advantage of directly using job proficiency measures as criteria. It suggests that different jobs do have different levels of literacy demands and that reading requirements for these four jobs are well above the levels typically set as objectives for remedial reading training programs. However, there are drawbacks to this approach. Clearly, it is prohibitively expensive to obtain hands-on job proficiency measures in a variety of jobs. A different problem arises from the job proficiency measures themselves, for they represent the resultant effect of many factors, of which literacy is only one. Since the job proficiency approach only involves the job reading materials if the person chooses to use them, an approach was taken that included direct study of those reading materials used in training for and performing the job.

Readability approach. The second approach to determining job reading requirements was to study the reading difficulty level of Army manuals used on various jobs. The FORCAST readability index was constructed to estimate the reading grade level of ability needed by the adult Army population to read and comprehend technical job reading materials. The formula for determining the reading grade level of job technical materials using this index is—

$$\text{Reading Grade Level} = 20 - \frac{\text{Number of 1 syllable words in a sample of 150 words}}{10}$$

This formula was developed using Army job technical materials administered as reading tests to young Army recruits. It is, therefore, a special readability tool for estimating young adult performance on reading tests (cloze format) consisting of job materials.

FORCAST estimates of the readability of manuals indicated these results:

- More than half of the job manuals in each of the seven jobs exceeded the eleventh grade level of reading difficulty.
- The average readability level of the materials in each of these jobs far exceeded the average reading ability of personnel working in these jobs.

The readability technique offers a low-cost method for estimating the overall reading demands of job manuals. However, it does not provide a direct indication of how well personnel can read and use their manuals for the reading tasks performed on the job; for this information, one needs to test people on samples of job reading tasks using job reading materials.

Job reading task tests. The third general approach to assessing job literacy requirements consisted of studying directly the relationship between general literacy skill and performance on job reading task tests, that is, reading tests constructed of actual job reading materials used in performing actual job reading tasks. Job

reading tasks were identified by means of structured interviews with job performers at their work location. Job performers were asked to report instances of their use of printed materials in performing job tasks, to describe the information they sought to perform the job, to obtain the printed material, and to indicate the needed job information in the manual. These verified job reading tasks were then structured into Job Reading Task Tests that were standardized and normed on Army samples whose general reading ability level was also measured.

These tests consist of the most frequently mentioned types of reading material and require the individual being tested to obtain the same kinds of information from the same manuals as job incumbents reported using in their work. Thus, they represent the most direct measure of actual job-specific reading task performance.

Each of the Job Reading Task Tests (JRTT's) constitutes a set of content-valid, job-specific reading tasks that can be used as a criterion-referenced measure of job reading task performance for that job. To facilitate comparison of job reading requirements, as defined by a JRTT, between different jobs and with other indices of job reading requirements, JRTT scores were scaled in terms of reading grade level, as measured by a standardized reading test. Thus, any job-specific JRTT score could be expressed as the performance of a soldier whose general reading comprehension was at some specified reading grade level, to use that common metric. In this fashion, and using the arbitrary but plausible decision rule that 70 percent of job incumbents should get 70 percent of the items correct on the JRTT, the reading requirements for cooks was shown to be about the seventh grade level, for vehicle repairmen, the eighth grade level, and for supply clerks, at the twelfth grade level.

To summarize, these were the three main approaches to determining the reading level requirements of jobs in the Army. Each studied the relationship of general reading ability to a different criterion: measures of job proficiency, the structural properties of job reading materials, and the performance of empirically determined job reading tasks. These approaches agree in general in estimating different reading requirements for different jobs, and in a common ordering of the literacy requirements of the three jobs studied in all approaches.

From this work the following conclusion can be drawn: although no single level of functional literacy can adequately represent the reading requirement of the range of jobs studied, there appears to be a lower limit of seventh grade reading level for functional literacy in the Army. Thus, remedial reading should be aimed at producing no less than seventh grade reading ability and, optimally, should be targeted to the level of a job assignment. If elimination, retention, or promotion of career personnel is largely contingent upon paper-and-pencil job knowledge tests, formal procedures should be implemented to ensure that personnel have the opportunity to acquire both the job knowledge and the literacy skills required by the tests.

Job Functional Literacy Training Program

Based on the research on the nature of its literacy problem, the Army in 1971 sponsored the FLIT (Functional Literacy) project to develop a literacy training program that would provide a level of functional literacy appropriate to present minimal job reading requirements and that would require no more than six weeks of training time. Given the absolute constraint of six weeks of training, there appeared to be no reasonable prospects of increasing the adult students' general literacy competence to the point where it would transfer significantly to job reading tasks. Accordingly, the FLIT objective was specified to be that of producing a student capable of using job reading materials with the effectiveness of a person having a general reading ability of grade seven or higher, as indexed by performance on a job reading task test. This was to be accomplished by ensuring that all job reading training would be conducted using the concepts, content, and reading materials of the student's own job area. Parallel training curricula and materials were developed for each of six job clusters: cook, clerk, communications, combat, mechanic, and medic.

Entry. Entry into the program was governed by a series of screenings designed to eliminate most cases of testing artifact. All recruits scoring in the military's lowest aptitude categories were screened on a standardized reading test in the Reception Station during recruit processing. Those failing to reach the sixth

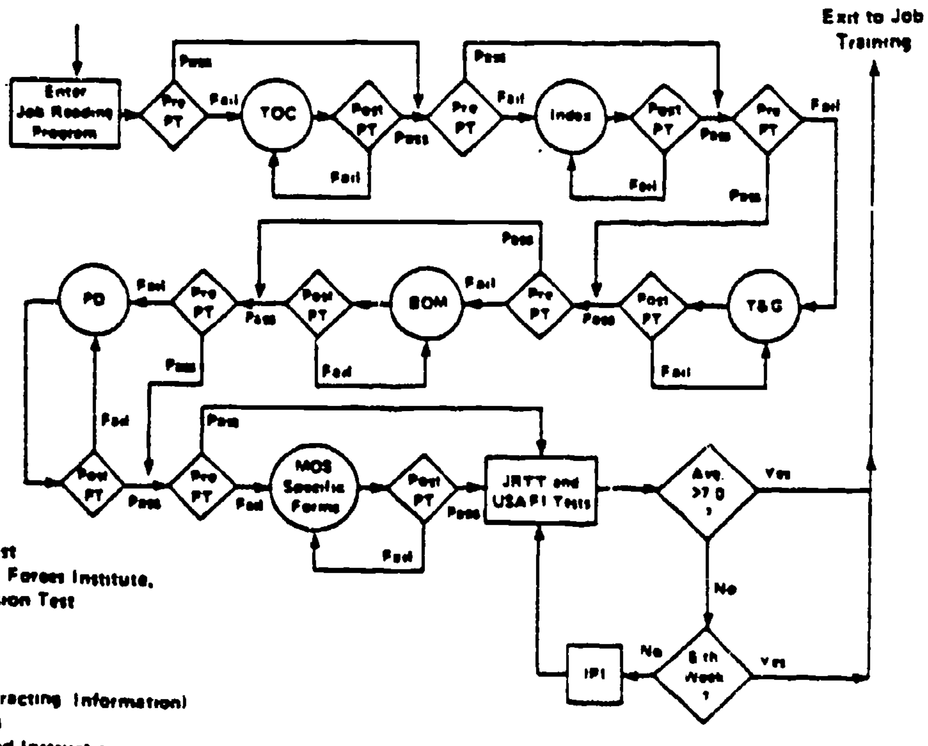
grade reading level were rescreened five weeks later in basic training. Using both a general and a job reading test, those again scoring below the sixth grade reading level were screened once more upon entering the reading training at the end of basic training. Only those students who failed all three screenings were admitted to the job reading training program.

Program overview. The functional literacy training program consisted of three curriculum strands, each of which occupied about one-third of each training day. Strand I was designed to provide training in the application of existing general reading skills to job-specific Army job reading tasks. Strand II was designed to improve basic reading skills and job knowledge by using simplified versions of Army job reading materials and special "information representation and transformation" procedures described later. Strand III was a free reading period allowing students to read from job-related or general materials of their choosing. Strand III is not discussed further in this report.

STRAND I: READING TO DO

Strand I. Strand I training was designed to give the student drill and practice in applying existing reading skills to the job reading tasks and the job reading materials that were encountered in entry-level job training and job performance. This strand was a modular, self-paced, mastery-based program of job reading task training. Training was conducted in six modules, each addressing one of the six fundamental job reading tasks identified as common and essential to job training and performance. These modules provided training in six job reading tasks: using a table of contents, using an index, using tables and graphs, using the body of the manual to look up facts, following procedural directions, and filling out forms.

Students began a module on the basis of a pretest score. Students meeting both time and accuracy criteria on a module pretest advanced to the next module. Those failing the pretest entered the module's successive blocks of individualized instruction until they could pass a module posttest. Figure 3.1 depicts the modules and their sequence in Strand I.



Legend

JRTT = Job Reading Task Test
USAFI = United States Armed Forces Institute, Reading Comprehension Test
PT = Proficiency Test
TOC = Table of Contents
T&G = Table and Graphs
BOM = Body of Manual (Extracting Information)
PD = Procedural Directions
IPI = Individually Prescribed Instruction

Figure 3.1

Strand I of the Job Functional Literacy Program

Development of Reading Tasks, Instructional Activities, and Assessment Procedures

Identification of Job Reading Tasks: The necessary first step toward the development of Strand I job reading program was the identification of the job reading tasks to be taught in the program. Much of the initial development in this area was conducted in previous research projects which produced a scheme for classifying the various types of job reading tasks.

In this research, a job reading task was defined as a task in which a person obtains (or attempts to obtain) information about a job by reading from a manual, book, form, or other job-related printed material. Job-related printed material is, by definition, material which presents information about the various tasks comprising a job. Hence, a job reading task involves a piece of reading matter which presents some job information and a reader who attempts to use the reading matter to obtain the job information.

The types of job reading materials used and the job reading tasks performed on the materials were identified by means of a structured on-the-job interview. Each man was asked to cite five instances in which he had used printed materials in his work in the last month or so. He was also asked to locate the printed material, show the interviewer the exact page and section he had used, and tell what kind of information he had been seeking.

In addition to identifying job reading materials, the interview provided data about the nature of the information, a man had been seeking when he used the material—in other words, the kinds of questions men working on the job addressed to the job reading materials.

From the classification scheme for determining the general content-type categories of job reading tasks, we operationalized these categories into six specific job reading tasks. These tasks then became the base from which the Strand I materials were developed.

These tasks are:

1. Using a Table of Contents to gain information about the general content of the manual and the location of various content areas in the manual.

2. Using an Index to gain information about specific content and its location in the manual.

3. Using Tables and Graphs to gain specific information displayed in tabular or graphic form.

4. Using the Body of the Manual to gain descriptive or theoretical information from the prose sections of the manual.

5. Following Procedural Directions to gain information from a step-by-step description of how to carry out a specific job related activity.

6. Using detailed, specific instructions in a manual to gain information about the type of information required in a Job-Specific Form and the procedure for completing the form.

31 October 1966 | C 1, AR 40-4
*AR 40-4

ARMY REGULATION
No. 40-4

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 14 July 1961

MEDICAL SERVICE

ARMY MEDICAL DEPARTMENT FACILITIES

Effective 1 July 1967

*This regulation supersedes AR 40-4, 18 May 1964; including C 1, 18 February 1966; C 2, 10 August 1966 and C 3, 1 May 1967

[illegible] | [illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible]

[illegible]

11. [illegible]
12. [illegible]
13. [illegible]
14. [illegible]
15. [illegible]

Figure 3.2

A Sample of a Section of the Medic Table of Contents Proficiency Test

Table 3.1

Definition of Content-Type Categories

1. Tables of Content and Indexes:
   Content designating the location of information within a publication.

2. Standards and Specifications:
   Content setting forth specific rules or tolerances to which task procedures or the completed product must conform.

3. Identification and Physical Description:
   Content attempting to symbolically represent an object via an identifying code (stock number, nomenclature) and/or by itemizing its distinguishing physical attributes.

4. Procedural Directions:
   Content which presents a step-by-step description of how to carry out a specific job activity. Essential elements are equipment/materials/ingredients to be used, and how they are to be used, with presentation organized in a sequential step-wise fashion.

5. Procedural Check Points:
   Content which presents a key word or highly summarized version of what should be done in carrying out a task rather then how it should be done. This content differs from the content classified under Procedural Directions in that it assumes the user knows how to carry out the steps once reminded that the step exists and/or reminded of the decision factors which determine whether the step is required.

6. Functional Description:
   Content which presents an operating (cause and effect, dependency relationships) description of some existing physical system or subsystem, or an existing administrative system or subsystem.

Selection of Instructional Principles: The final step to be performed before the student instructional materials were developed was to select the instructional principles to be used in the program. These principles defined the parameters within which the job reading instruction would take place. Some of these principles were determined by the initial concept of a "job related" program, others were determined by the developmental constraints placed on the program, and some were selected based on our review of current military and civilian adult literacy programs. All of the instructional principles, however, had been used with success in a wide variety of educational and training situations.

The six instructional principles selected are:

1. Individualized instruction: This permits students to progress through the program at their own rate using materials oriented toward their jobs.

2. Performance-oriented instruction: This training permits students to perform the kinds of reading tasks they will encounter in job training and out on the job; thus, there is a direct transfer of skills learned in the literacy school to the job training school and the job.

3. Functional instruction: Through the use of actual job reading material, the student sees the purpose for the reading training in concrete terms of job proficiency, not as general educational development, at which he has failed many times in the past.

4. Student-assisted instruction: Students are used in the more routine records management activities in the classroom. Periodically, a student may tutor another student on a skill which he, himself, has previously learned. These activities cut down the teacher's administrative paper-correcting load, and help the student "stamp-in" more deeply some of the skills he has just learned.

5. Programmed instruction: The program is composed of six separate modules of linearly sequenced job reading skills (Table of Contents, Index, Tables & Graphs, Body of the Manual, Procedural Directions, MOS Specific Forms). Each module has a branching loop for remedial instruction.

6. Quality control monitoring of performance: Each module has its own set of proficiency tests. These are used to assure that the student has developed a mastery of the reading task before proceeding to the next module. Each proficiency test (or pro-test as they are generally referred to) is made up of four sections, each with its own set of five questions. To satisfactorily master the task, the dual criteria of 90% or more correct, in 2C minutes or less, must be met.

STRAND II: READING TO LEARN

Strand II. In contrast to the individualized, self-paced program of Strand I, Strand II was a teacher-oriented program designed to improve comprehension and learning skills using job reading materials. To read for learning, people must be prepared in at least two ways: they must have the knowledge base to comprehend the material to be learned, and they must possess knowledge of skills for studying materials and relating what they read to what they already know.

To promote the acquisition of a relevant knowledge base that would help literacy students learn better from their job training materials, Strand II curriculum included specially developed materials that were written at a lower difficulty level than those encountered in job training and that incorporated the basic concepts and topics within a given job. The basic concepts for the six job fields in the functional literacy program were identified through study of job skills training program curriculum guides and consultation with job training instructors. In each job reading program, 12 major concepts were identified, and specific knowledge objectives were developed for each concept area.

For each of the 12 job concept areas, a 300-400 word passage was written that included the knowledge objectives for the concept. These passages were written at the seventh to ninth grade level, as determined by the FORCAST readability index. The concept passages were written without the redundancy and elaboration usually needed to explicate concepts in written materials, because in the Strand II activities each student performed repeated readings of the materials and constructed various representations of messages in the passages. For instance, in some cases students read the concept passages and then drew pictures of what they had read. In other cases, students read the concept passages and produced classification tables or flowcharts representing the major concepts presented in the passages. Having transformed concept passages into pictures, classification matrixes, or flowcharts, students then discussed their newly developed representations, thus producing another representation transformation.

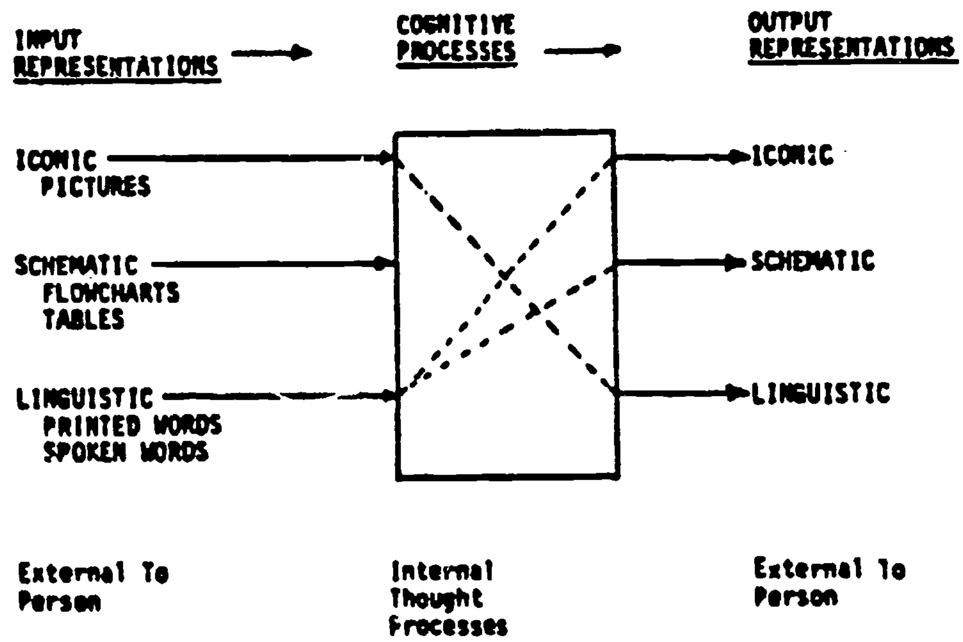


Figure 3.3

Comprehension indicated by use of different ways of representing concepts.

them by superordinate and subordinate categories, in the case of classification tables, and by sequential steps and decision branching points, in the case of flowcharts. These analytical techniques helped to clarify what the written passage was all about.

Generalizing the Simple Model of the Development of Literacy to Include a Broader Range of Literacy Tasks

Earlier, the simple model of the development of literacy skills was described briefly. There it was pointed out that both speaking and writing are processes for representing thoughts in external displays, which people learn to decode to form internal representations through the processes of auding and reading, respectively. Now it should be noted that there are other methods of representing thoughts externally than the linguistic modes. People can draw pictures, for instance, or produce gestures or bodily postures. Or, we can externally represent thoughts through a combination of linguistic and non-linguistic representations: figures, graphs, tables; we can record our speech and gestures on video-cassettes, and so forth.

To bring some order into all of these modes of representation of thoughts, they have been divided into three main categories: iconic, schematic, and linguistic modes of representation. Now it is assumed that by means of mental "programs" we have stored in our memories, we are able to externalize certain of our concepts by drawing pictures; this type of representation is referred to as iconic representation. Linguistic representation of thoughts is produced by speech or writing, and schematic representations are an admixture of iconic and linguistic representations—for example, flow charts, tables, graphs, etc.—that contain both visual structural features and (generally) linguistic signs in the forms of labels or short phrases.

These various representations are displays of information that can be examined by others; i.e., we can consider that there are three categories of input display—iconic, schematic, and linguistic—that people can attend to. Furthermore, the information in a given type of display—say a linguistic display—may, at times, be representable in some other type of representation—say an iconic representation. For example, information presented in written form might be used as source materials from which a picture might be drawn that could represent essentially the same meaning as in the written message. Thus, for instance, one may write, "The cave man threw a rock into the water." This might alternatively be represented as Figure 3.4.

As another example, one might say "In our research project we found that as the number of years of education increased, the reading skill level increased up to about the tenth grade, and remained the same thereafter." Alternatively, one might draw Figure 3.5 and say that, "Figure 3.5 shows the results of our study." Clearly, reading skill is a function of years of education, at least for up to 10 years of education.

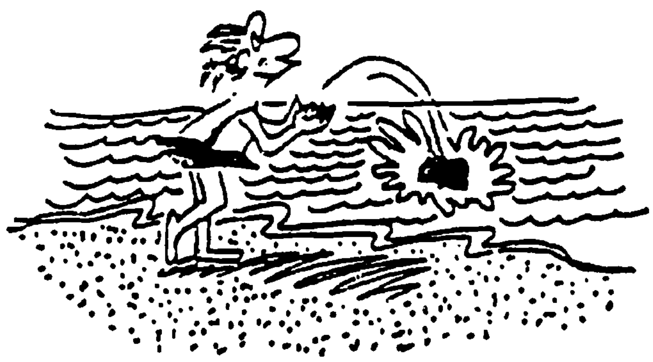


Figure 3.4

Example of iconic representation.

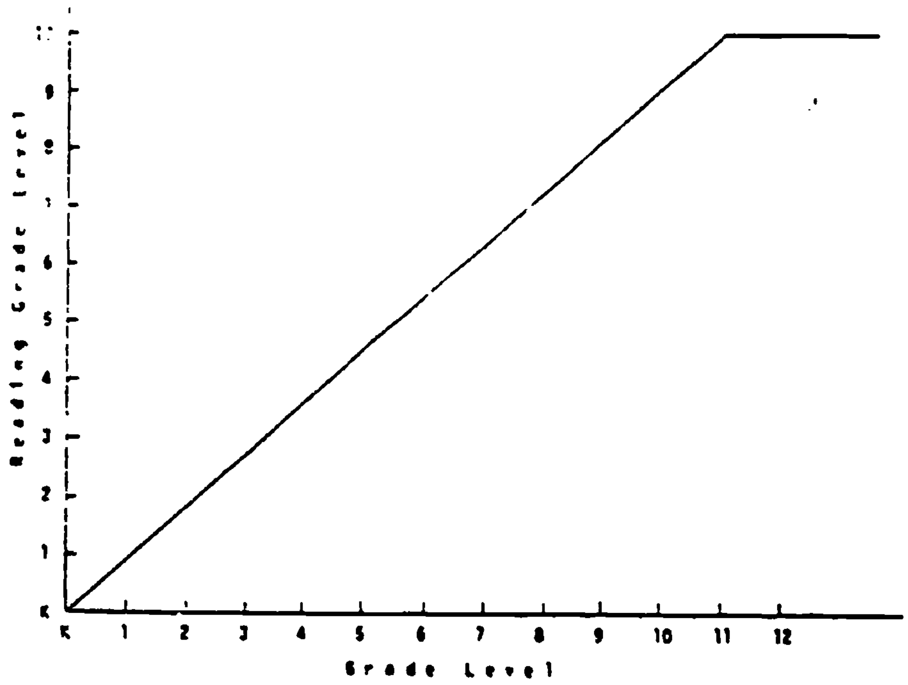


Figure 3.5

Example of schematic representation

As an final example, one might wish to explain to someone that:

You are eligible to apply for an old age pension if you are 65 years old and have contributed to the fund for at least five years. However, if the five years of your contribution were prior to 1970, then you are not entitled to the full pension, but rather to 1/2 pension if you are 65, and 3/4 if you are starting at age 67 . . ."

Alternatively, one could represent this as in Figure 3.6.

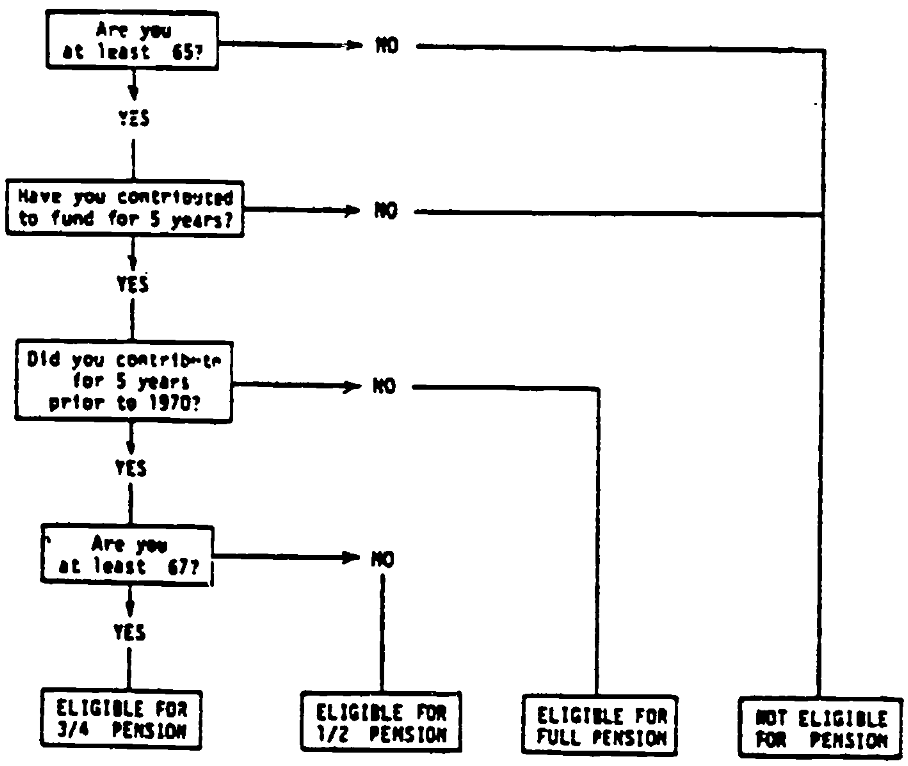


Figure 3.6

Example of schematic representation

Mortar and artillery squads and platoons control indirect fire through Mortar Gunnery Teams and Field Artillery Gunnery teams. Each team has three parts: (1) an observer, (2) the fire direction center (FDC), and (3) the weapon crews or firing battery. The observer finds enemy targets and reports their position to the FDC. The FDC figures out the firing data, which includes the direction and range from the weapons to the target. The FDC sends a fire command to the weapon crews. The crews lay and fire the weapons. The observer can see where the rounds fall. If they do not hit the target, he can adjust the fire. He does this by sending back corrections to the FDC. He tells if the rounds went over the target or fell short of it, or whether they fell to the left or right of the target. The FDC changes these corrections into a new fire command to the weapon crews. The crews lay the weapons again and fire. In this way, mortars and artillery can hit targets that the weapon crews cannot see.

A: Linguistic Representation

B: Iconic and Linguistic Representation

(this is a free-hand copy of a drawing made by an adult literacy student with reading skills less than the fifth grade level.)

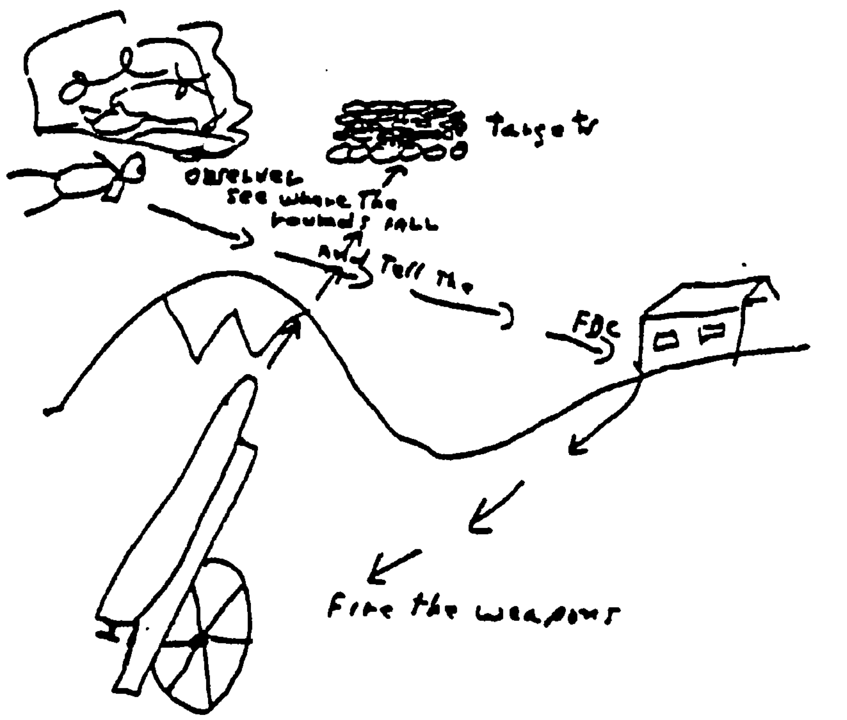


Figure 3.7

A representation transformation task in which the linguistic representation of Part A is transformed into the iconic representation of Part B.

As indicated, then, it is possible to express very nearly the same ideas in alternate modes: iconic, schematic, and linguistic. Of course, there are thoughts that can only be represented in one or the other modes. And, there are cases when representation in one mode is better for some purpose than an alternative mode.

<u>Analyzing Sentences</u>: In addition to the representation transformation activities, the Strand II program included special instruction in how to analyze sentences to determine the main idea and more about the main idea. The instruction in analysis was developed for the lower-level Army readers when it was discovered that many of these students had difficulty in figuring out who was doing what to whom or what in many sentences.

The languaging segment introduces a new model of sentence structure. Why not use traditional grammatical models of structure? The reason is simple—traditional grammatical models of sentence structure can become quite complicated, much too complicated for marginal readers to master in a few weeks' time. The terminology is complex. Consider these few examples: Direct object, indirect object, gerund, participle, predicate complement, prepositional phrase, and dependent clause. The number of "rules" that must be mastered to use this system on a wide variety of sentences would be quite high. So we have constructed our own model of sentence structure—a model that is not a contradiction of traditional grammar, but rather one that is based squarely on traditional grammatical structures. It is a "stripped-down" model designed to be simple enough to be learned by learning a small number of "rules," yet comprehensive enough to apply to most sentences which occur in job training and performance materials.

The structure and terminology of the languaging model is based largely on thought units and the kinds of information which each thought unit contributes to the complete idea expressed by the sentence. The most basic structure divides the sentence as follows:

MAIN IDEA	MORE ABOUT THE MAIN IDEA

The main idea can be separated into two thought units.

MAIN IDEA		MORE ABOUT THE MAIN IDEA
SUBJECT	ACTION	

The Action thought unit in a sentence may be one of three kinds: Active, Passive, or Is-Ness. (The Action: Is-Ness corresponds to linking or copulative verbs). The thought units which tell more about the main idea may present six different kinds of information. Figure 3.8 presents the complete basic model of sentence structure.

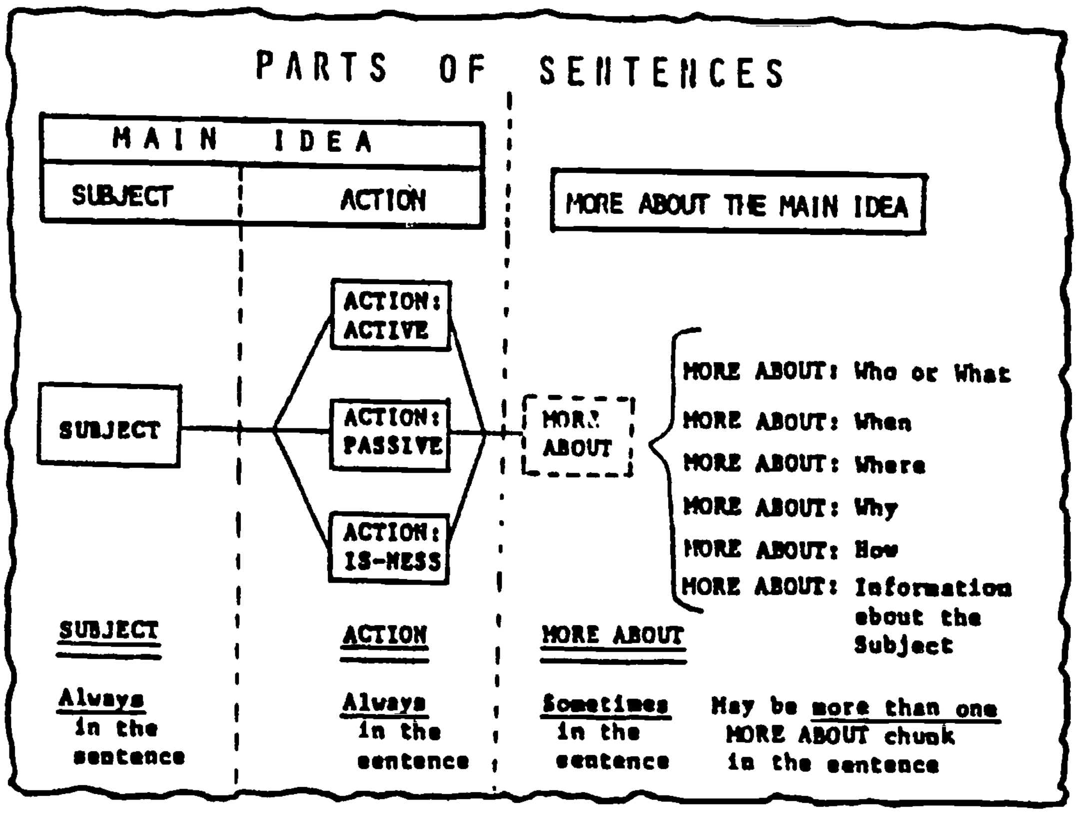


Figure 3.8

Basic Model of Sentence Structure

Evaluation of the Job Functional Literacy Program

Evaluation of the job reading program coi ·isted of several sets of test scores and the results of a limited amount of follow-up questionnaire data. Summative evaluation of the functional literacy program was obtained from the pre- and posttesting of performance in the general and job reading task test as indicated in figure 1 for Strand I. Finally, Strand II effectiveness was evaluated in a small-scale study in which specially constructed representation transformation tests were administered before and after training in the Strand II activities. In the following discussion, the Strand I formative data will be discussed first, followed by a discussion of the Strand II evaluation study. Finally, the summative evaluation and follow-up questionnaire data will be presented.

Training effectiveness of modules. Five of the Strand I modules yield data suitable for evaluating the instructional effectiveness of the separate modules: Table of Contents, Index, Tables and Graphs, Body of the Manual, and Procedural Directions. Table 3.2 presents the pre- and post-proficiency test scores for these five modules. As indicated in the column—failed or did not complete—many people were not able to master the criteria for each proficiency test. They were moved into the next module anyway for practice in that skill. However, since the modules do not represent a hierarchy, no cumulative learning problem resulted from this practice as far as is known.

Table 3.2

Strand I Effectiveness Data

Module	N	Passed Pretest %	Passed Posttest %	Failed or Did Not Complete %	Training Effectiveness %
Table of Contents	710	19	67	14	83
Index	710	16	56	28	67
Table & Graphs	710	20	53	27	66
Body of Manual	710	3	49	48	48
Procedural Directions	710	9	30	61	33

As Table 3.2 indicates, the training effectiveness, which is the percentage of those reaching criterion divided by the percentage attempting the module, was better for the Table of Contents than for the other modules, indicating the relative ease of the Table of Contests tasks. The Procedural Directions module had the lowest success rate. It was also the last module with a pre- and post-proficiency test, and many people did not have much practice in this task. Overall, though, these data indicate that considerable improvement was achieved by the students who worked in these job reading training modules.

Training effectiveness of representation transformation training. A small-scale study involving students in the job reading program was conducted to evaluate the effectiveness of the representation transformation training of Strand II. To evaluate the training, tests were constructed that involved the student in transforming a prose passage into either a classification table or a flowchart.

Figure 3.9 presents an example of the test for the classification table. At the top of each test is an example of a text, below that is a representation of the text transformed into a table. Then there is another piece of text. Using this passage, the student is supposed to transform information in the passage into the type of display shown in the top half of the page. To score the classification table test, four points are awarded

BEST COPY AVAILABLE

for constructing four appropriately labeled columns, and one point each is awarded for four correct entries per column, making a total of 20 possible points.

Figure 3.10 shows the layout for the flowchart transformation test. The layout parallels that for the other test; at the top of the page is an example, at the bottom is a text to be transformed into a flowchart. Scoring is somewhat more complex for this test. First, the student gets one point for each correctly used symbol: for example, circles for start and finish, rectangles for operations, diamonds for decisions, and arrows (with heads) showing process flow (subtotal of four points). Then, the student receives one point for identifying each operation, including the start and finish operations designated by the circle symbols (a possible 11 points) and one point for correctly identifying and labeling the branching decisions. Thus, a total of 16 points is possible for the flowchart test.

Types of Bars

Crowbars are used for moving timbers and rocks. They are available in 4 and 5 foot lengths with a diameter of 1 or 1 1/4 inches. Pinch bars are from 12 to 36 inches long and are used for prying out spikes and nails. Pinch bar diameters range from 1/2 to 1 inch depending on their length. Wrecking bars have diameters of 1/2 to 1 1/8 inches and are available in lengths from 12 to 60 inches. They are used for the same things as crowbars. Pry bars are used for prying out gears and bushings. They are 16 inches long and have a diameter of 1 1/16 inches.

Type	Use	Length	Diameter
Crowbar	Moving timbers and rocks	4-5 feet	1 or 1 1/4 inches
Pinch bar	Prying out spikes and nails	12-36 inches	1/2 to 1 inch
Wrecking bar	Moving timbers and rocks	12-60 inches	1/2 to 1 1/8 inch
Pry bar	Prying out gears and bushings	16 inches	1 1/16 inches

When You Are Lost - Eat Plants

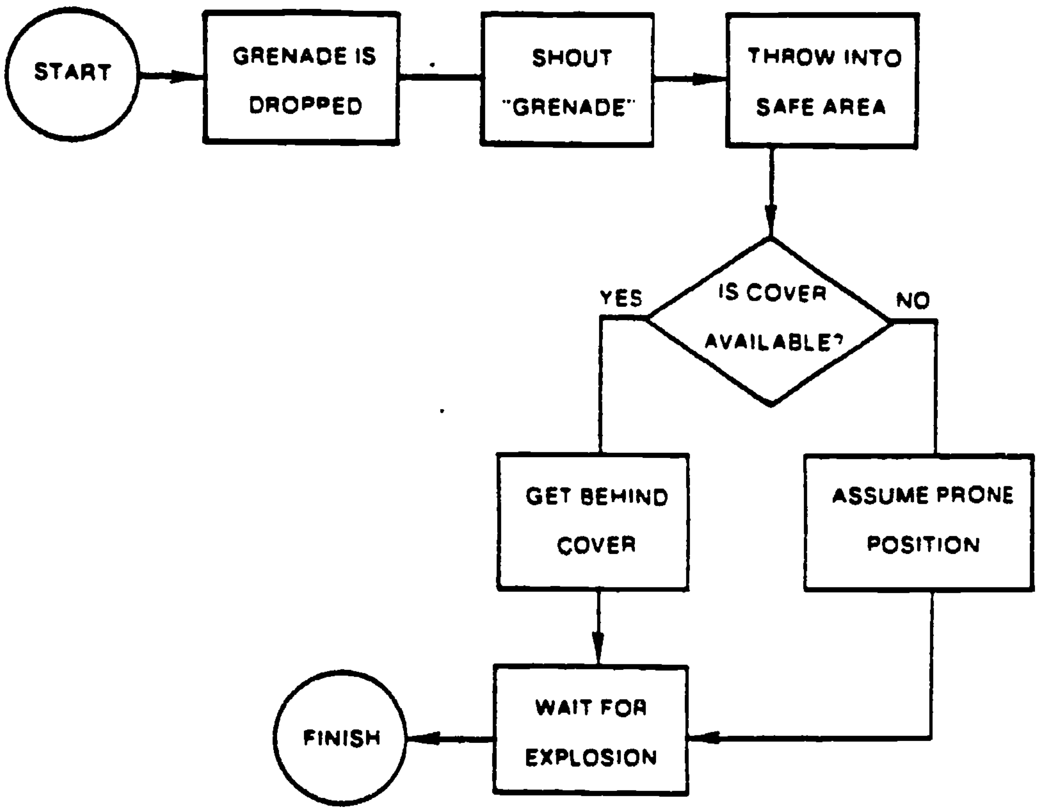
If you are lost and out of food there are many types of plants that you can eat. Marsh marigolds are best during early spring. They are found in swamps and in streams. The leaves and stems are the only parts that you should eat. The leaves, stems, and flowers of the rock rose are all good to eat. You can find them along streams and lakes in early spring. Fireweed is also good to eat. It is usually found in burned-over areas during spring and summer. You can eat the leaves and flowers of the fireweed but not the stem. The roots of the mountain willow are also good to eat. Mountain willow is found in high mountains in early summer.

Figure 3.9

Representation transformation test: Classification table

When a Hand Grenade Is Dropped

When a hand grenade is dropped accidentally after the safety pin is removed, shout "Grenade." Then pick up the grenade and throw it into a safe area. The individual should then get behind any available protective cover until after the grenade explodes. If no protective cover is available, assume the prone position until after the explosion.



Throwing a Grenade

The first step in throwing a grenade is to remove it carefully from the box. Remove the protective cover, hold the grenade carefully, and walk to the throwing area. Before you throw the grenade you must grip the grenade in the right way. If you are right-handed, grip the grenade in the right hand with the top pointing up and put the safety lever under the thumb. If you are left-handed, hold the grenade in your left hand and point it toward the ground and put the safety lever under the thumb. When you have thrown the grenade, get behind protective cover.

Figure 3.10

Representation transformation test: Flowchart

BEST COPY AVAILABLE

The 36 students who participated in the evaluation study took the above tests as pre- and post-training tests. The results are shown in figures 3.11 and 3.12. Clearly there was some improvement in representation transformation skill from the first to the second testing, which was separated by not less than four weeks. On the other hand, there was nothing like 100 percent mastery of these skills in particular, the flowchart data indicate that considerably more practice would be needed to move all students to the mastery level. Nonetheless, these data do suggest that students improved their skills in performing these types of tasks, with mean improvement scores moving from 65 to 95 percent in the pre- and post-classification tests, and from 37 to 61 percent in the pre- and post-flowchart tests.

Summative evaluation of the overall program. Summative evaluation of the Functional Literacy (FLIT) Project was accomplished through pre- and posttraining administration of alternate forms of the reading comprehension portion of the U.S. Armed Forces Institute (USAFI) Intermediate Achievement Test and the FLIT Job Reading Task Test (JRTT). Effectiveness of the FLIT reading training program can be assessed by the gain on these composite measures of general and of job reading performance over the six-week period of FLIT training.

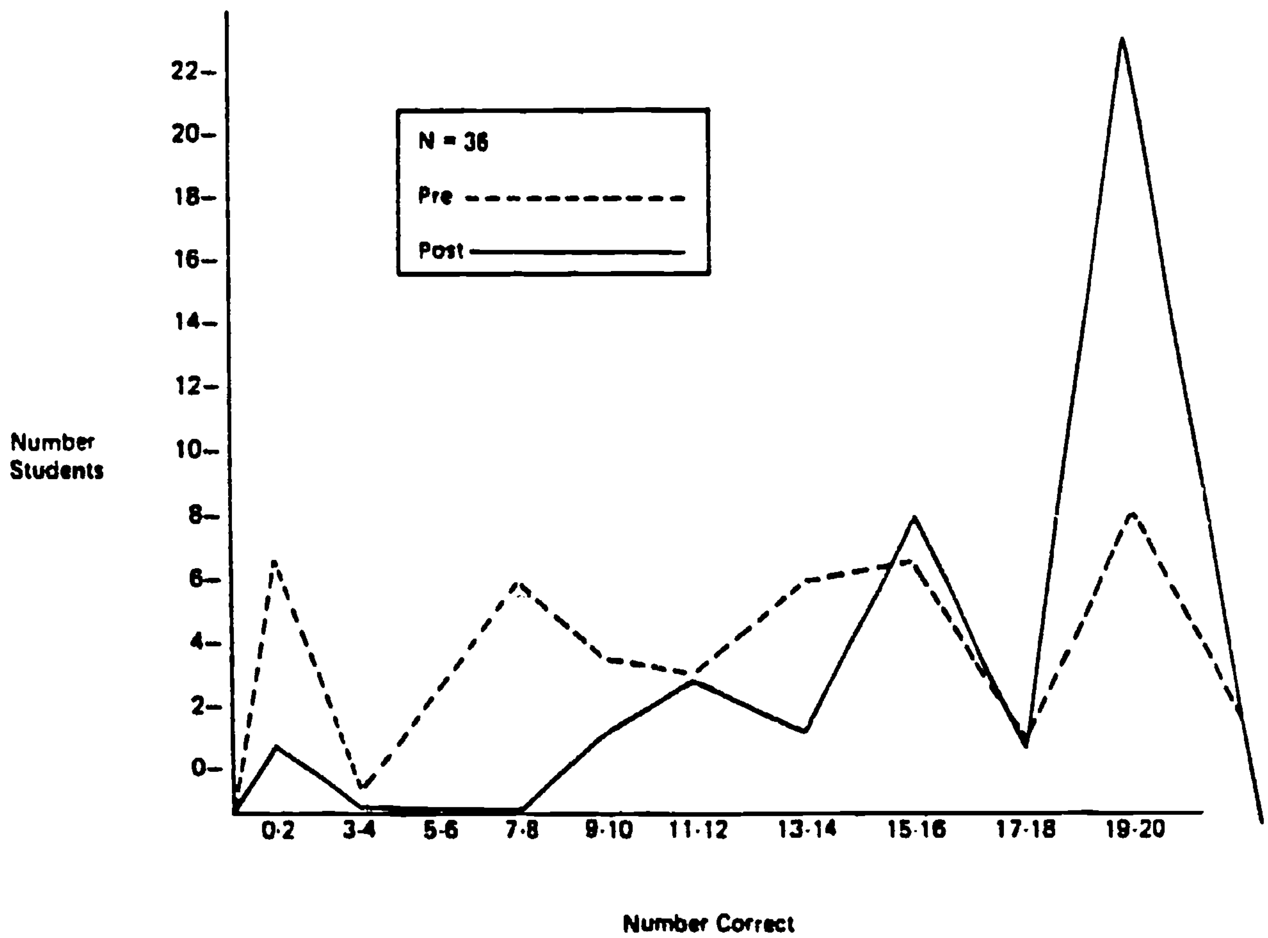


Figure 3.11

Pre- and posttest distributions for the classification representation transformation reading task test.

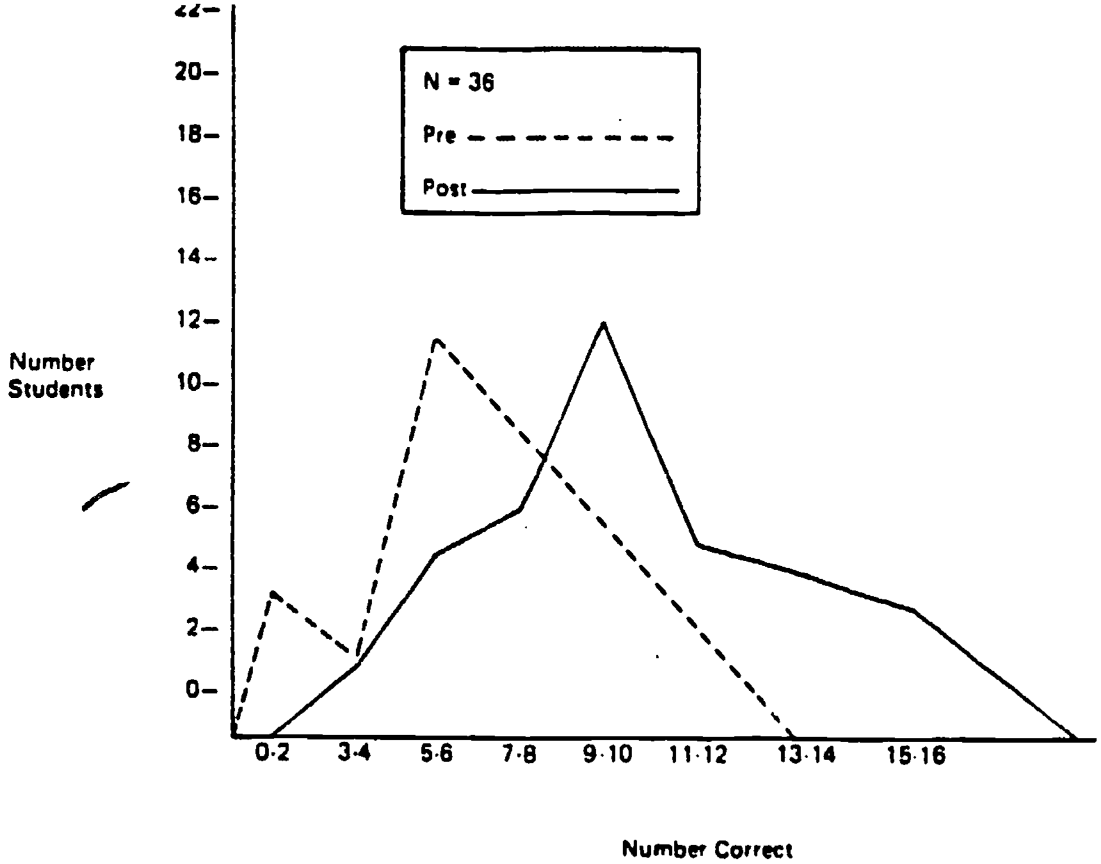


Figure 3.12

Pre- and posttest distributions for the flowchart representation transformation reading task test.

Table 3.3 presents the data on the mean USAFI and JRTT reading grade level (RGL) of FLIT students. In these data, which are free of the regression artifact that has flawed the assessment of so many remedial reading training programs, students enter FLIT performing both general and job reading tasks equally well (or poorly)—low in the fifth-grade reading level. After six weeks of FLIT training in general and in job reading, students have gained 2.1 RGL years on the JRTT measure of job reading (three times the gain made in general reading) and the end-of-course average JRTT score exceeds slightly the targeted course objective of RGL 7.0. The .7 RGL gain on the USAFI measure of general reading is in full accord with typical findings of adult general reading training programs of from 50 to 100 hours of instruction.

Additional evaluation test data. Additional evaluation data were obtained that compared the job literacy training achievements to reading improvement by a group of Army personnel who received job technical skills training, but no literacy training. Results showed superior gains in job-related reading for the reading training group. Similarly, comparisons of the functional-literacy-trained students to students in Air Force and other Army literacy training programs indicated that the functional literacy training produced two to four times the amount of improvement in job reading as the general literacy programs did, while the job reading program equaled the general literacy programs in the amount of general test improvement acomplished.

Questionnaire data. Further indication of the effectiveness of the job reading program was obtained through feedback from graduates who had gone on to job skills training. Of 353 questionnaires sent out, 74 (20 percent) were returned completed. Of these, 8 out of 10 felt that the job reading training helped them in their job training. Several suggested modifications to the functional literacy program. Thus, though such low return rates are not satisfactory to warrant elation, the questionnaire data lend slightly more evidence for the effectiveness of the FLIT program.

Table 3.3

Summative Data for the Functional Literacy (FLIT) Program

Type of Reading	N	Reading Grade Level		
		Entry	Exit	Gain
General Reading (USAFI)	714	5.3	6.0	.7
Job Reading (JRTT)	714	5.2	7.3	2.1

Summary and Conclusions

A program of research and development was summarized that (1) developed methodologies for the study of literacy requirements of jobs within a specific organizational setting, the United States Army, and applied these methodologies in determining the reading requirements of a set of Army jobs and (2) designed, developed, evaluated,and implemented an operational, job-related, functional literacy (FLIT) program for the Army.

Results of the above activities indicate that in the job reading training program, job reading of job materials showed larger gain than general reading. This is important because it indicates that people are learning what they are being taught in a very specific manner. In many evaluation studies, standardized reading tests are used to evaluate programs with no good rationale as to why it is believed the test scores should improve. Usually, there is no demonstration that the standardized test scores reflect what is being taught. Clearly, the present results show that "reading" is not altogether a general skill, assessable by any test of "general" reading. The job reading task tests show that specific literacy skills can be developed and assessed for generalizability in the domain area that corresponds to what was taught. The latter point was demonstrated in the present research by the fact that performance in the job reading task tests (JRTT) improved considerably, even though the specific content and questions asked were not included in any training module.

The fact that general competency in a specified domain was improved in the job-related reading program suggests that if reading training is given in a well-specified domain, then skill in that domain should improve. If enough domains are developed, and if competency is assessed in these domains using appropriate domain-referenced assessment tests, then a person's "general" literacy should increase in proportion to the domains in which competency is achieved. This way, "general" ability is improved through the aggregation of "specific" abilities. It remains to be determined whether domains that cut across a number of other domains of specialization can be identified and directly taught as superordinate, generic skills of "general" literacy.

Discussion Questions: What are the differences between "general" and "job-related" literacy? Can "general" literacy be improved in the contexts of "job-related" literacy training? Does "job-related" literacy "empower" adult students? Does "general literacy?" Is there any way to know the literacy demands of a votech course? Of an academic course? How might one go about determining the most important demands of such courses?

Following the demonstration of the effectiveness of the FLIT program over traditional, k-12 school-oriented programs, the program was implemented nationwide at six Army training posts. Additionally, the Air Force developed a similar program (JORP—Job Oriented Reading Program) for students reading at between the 6th to 10th grade levels. A separate program was developed for the Army National Guard. Studies were conducted to compare the FLIT program to (a) a group of Army trainees who received only technical skills training but no job training; (b) an Air Force General literacy program; and (c) an Army general literacy program. Finally, the FLIT program was tried out in both an Extended Training day, in which students took the program after hours during the regular job training course, hence avoiding the six-week course offered before going to technical training, and in an Integrated Training day, as a separate unit during the same training hours as the technical training (thus avoiding after hours study halls).

Figure 3.13 presents pre- and post-test data in Job Reading Task Tests and General Reading Tests for these various programs. In each of the job-related reading programs, improvement in job-reading surpassed improvement in general literacy, though the latter improved to about the same extent as found in most adult general literacy remediation programs (see Sticht, Armstrong, Hickey & Caylor, 1987, for a more complete discussion of these data).

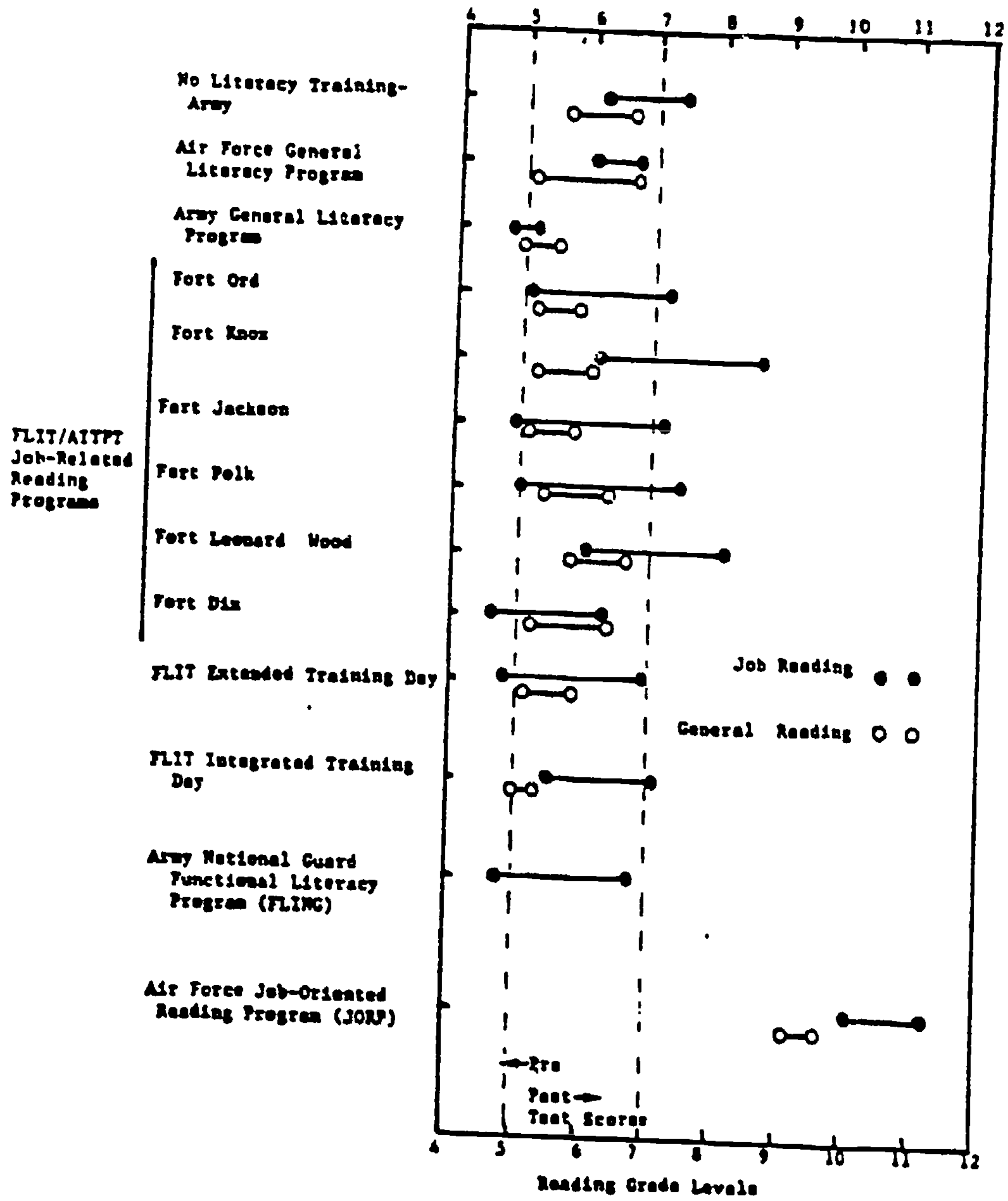


Figure 3.13

Data showing scores on pre- and post-job reading task tests and general literacy tests for different sites and FLIT training conditions.

BEST COPY AVAILABLE

CHAPTER 4

FCE CASE STUDY #2: READING AND MATHEMATICS PROGRAMS FOR CAREER ADVANCEMENT USING TEACHERS, BOOKS, COMPUTERS, AND PEERS

In this chapter we will discuss the Experimental Functional Skills Programs (XFSP) in reading and mathematics that the U.S. Navy is presently field testing. The programs were developed to replace programs being offered by a dozen or so contracting organizations world-wide. The contractor programs are "general" in their orientation, use grade-school-based, standardized reading tests to measure basic skills education need and growth, and do not incorporate computer technology. The XFSP programs were developed to provide "functional," Navy-related programs oriented to assist enlisted personnel meet requirements for career promotion to higher paygrades and responsibilities.

A very brief summary of the XFSP: Reading program is included below. This is followed by extracts from the XFSP: Mathematics student's "Information Processing" book.

TEACHERS, BOOKS, COMPUTERS, AND PEERS: INTEGRATED COMMUNICATIONS TECHNOLOGIES FOR ADULT LITERACY DEVELOPMENT

In this section, which will focus on the Navy's Experimental Functional Skills Program in Reading (XFSP/Read), we will first discuss the conceptual framework for the development process, including a simple model of the human cognitive system, the concept of functional context training, and the integrated communications technologies approach that brings together teachers, books, computers, and peer instruction in a flexible delivery system that can meet the needs of both students and the Navy organization. For instance, coordinated teacher-, book-, and peer-based instruction can be used in classrooms where no computers are available. Teachers can teach and model reading comprehension activities that can be applied to the functional, career-oriented book. To learn the higher-order cognitive tasks that involve analysis and communication of information from complex texts, peer teams work in social units like those typically found in work settings. Where computers are available for classroom work, a coordinated set of software packages permits students to receive individualized practice applying information processing skills to the contents in the specially designed books. The latter have been developed using concepts of considerate text (Anderson and Armbruster, 1984). Where it is not feasible or desirable to have teachers and large numbers of books, such as aboard submarines or in remote sites, stand-alone, computer-based instruction can be used.

In addition to the foregoing, this paper also provides an overview of a new approach to adult literacy assessment that moves away from the use of reading grade level scores to more appropriate Rasch item transform scores. The new assessment approach measures reading-to-do, reading-to-learn, and for the first time in a reading assessment battery, content knowledge, gained in the program. The latter, that is, domain knowledge, is then used to illustrate a new method for assessing the readability levels of content materials that takes account of a person's background knowledge in estimating the general levels of reading needed to comprehend school or work materials.

Following the discussion of the underlying concepts for the XFSP/Read program development, we present an overview of the program as it stands today. Then we discuss aspects of the assessment test battery

ERIC

we have developed to assess program effectiveness, including a small scale study to compare the Navy-related reading program to the general reading program offered by a local contractor. This is then followed by a brief description of the results of a preliminary application of the knowledge-based readability assessment method to a sample of Navy reading passages.

Human Cognitive System Model

In conducting the development of the XFSP: Reading program we have worked from a stripped-down, simplified model of a human cognitive system and the processes the system uses for extracting and representing information in the environment. The model is schematized in Figure 4.1 The model contains three major components, two of which are "inside the head," and the third component which is "outside the head" and includes various information displays produced by or comprehended by the cognitive components. The latter include the knowledge base, which is a long term memory that contains all the information and knowledge possessed by the person, and the processing skills, including language, that operate on the information in both the knowledge base and the external environment to produce comprehension, communication, and thinking. The model as depicted in Figure 4.1 is of one who possesses both oracy and literacy information processing skills. The literacy processes include all those used to recode written language into internal forms comparable to those used in oral language, and, in addition, to perform all those literacy tasks that are not instances of writing as a second signaling system for speech. The tasks unique to literacy are those made possible by the properties of graphic displays: they are more or less permanent (thereby permitting study), they can be arrayed in space (permitting the construction of forms, signs, flow charts, graphs, etc.), and they can use the properties of light (contrast, color) to guide attention and facilitate information processing.

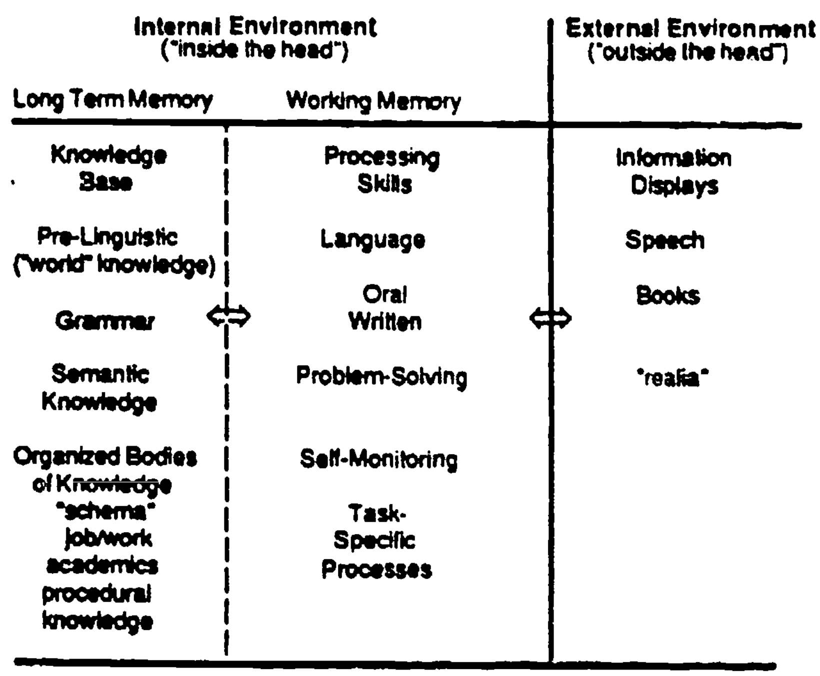


Figure 4.1

Cognitive system model for instructional program development.

According to the model of Figure 4.1, then, the performance of literacy tasks requires knowledge about what one is reading or writing (including mathematics knowledge when reading in that domain); processing skills for thinking about what to communicate or for comprehending what others communicate; and, of course, graphic displays of information in the environment to be processed for meaning. An important implication of this analysis is that it reveals that literacy, considered as the ability to comprehend and use the graphic symbol

systems of writing, graphing, illustrating, mathematics, and so forth, can be enhanced by improving either one's knowledge base in a given task domain, or one's processing skills, or, as in the case of improving the readability of materials, through the redesign of the graphic information displays the cognitive system must deal with, or a combination of these factors. Use of this conceptual framework in determining the learner's needs in literacy programs is illustrated later on, following a discussion of the functional context approach to instructional design that has undergirded the XFSP:Read program development activities.

The "Functional Context" Concept

Along with the simple cognitive model of Figure 4.1, we have followed what is known by some as the "functional context" approach to education and training development (Shoemaker, 1967). The essence of this approach is contained in two major goals for instruction. First, always try to make the instruction as meaningful to the learner as possible in terms of the learner's prior knowledge. This facilitates the learning of new information by making it possible for the learner to relate it to knowledge already possessed, or to make it possible for the learner to transform old knowledge into new knowledge. Second, as much as possible, use the materials and equipments that the learner will use after training or education as part of the instructional program. This will motivate the learner by showing that what is being learned is relevant to a future goal, and it will promote transfer of learning from the classroom to the next training or "real world" activity. In short, the functional context method of instructional design attempts to motivate and promote learning and transfer by making the program meaningful in terms of the learners past, present, and future.

Integrated Communications Technologies

The design of the XFSP/Read instructional delivery system is based on the premise that teachers, books, computers, and peers all form a set of communications technologies, based on human language and information processing skills that can be applied to socially organized tasks in classrooms aimed at bringing about learning. (See the Laboratory of Comparative Human Cognition Newsletter, July 1982; 1985 for related concepts). On this premise, teachers interact with students to present concepts and to model comprehension tasks for students. Peer teams perform complex analysis tasks, such as making semantic maps of texts and then representing these maps as flow charts, matrices, outlines, or tree structures. This simulates teamwork on the job to accomplish difficult cognitive and communication tasks. The contents and information processing skills that are taught in textbooks are reinforced through the use of microcomputers that offer discrete "game-type" activities, and integrated computer-based instruction. The goal then, has been not to see if teachers, books, and social learning by peers can be replaced by computers, but rather to find ways to better use all these "technologies" to the advantage of the learners and the sponsoring organization.

The XFSP/Read Program

The XFSP: Read program was developed following the guidance of the concepts described above applied in studies of what kinds of tasks Navy personnel perform using reading skills in training and job settings. In this research, students, instructors, and job performers in ten Navy jobs were interviewed and asked for information regarding two major types of reading tasks: reading-to-do something and reading-to-learn something. In a reading-to-do task, the person is performing some job task, needs some information from a document, looks up the information, holds it in working memory long enough to apply it, and can then forget it. In a reading-to-learn task, the person reads information to be stored in long term memory as part of the knowledge base, and then retrieves it (or a reconstruction of it) for use at some later time, such as taking an end of week test, or for performing a task on the job.

The interviews with personnel revealed that reading-to-do and reading-to-learn were performed to about the same extent in school situations, but on the job reading-to-do comprised about three-fourths of the reading tasks. It was also found that the processing skills performed in reading-to-learn were more complex than those used in reading-to-do. Whereas the latter emphasized information location and extraction skills, such as use of tables of content, indexes, "thumbing" or "flipping" through or searching tables and figures, reading-to-learn involved more elaborate activities to merge new information with old knowledge. The primary reading-to-learn processes were categorized into four groups: (1) reread or rehearse processes, in which learning was accomplished by rereading some portion of the material, or was repeated in some way over again to oneself; (2) question/problem solve processes, in which learners asked themselves questions about the material, or solved problems in textbooks; (3) relate/associate processes, in which the learners transformed what they read into some other form, either by paraphrasing, making internal images, watching a movie or demonstration and relating what they had read to the new information gained from these "iconic" or "realia" information displays (see Figure 4.1); and (4) focus attention processes, such as highlighting with colored pens, underlining, summarizing or some similar methods for focusing attention on a limited aspect of the material, usually in conjunction with a reread or rehearse activity later on.

The interviews also revealed the role of the knowledge base in performance of reading tasks. For instance, it was found that close to 60% of job tasks involving reading had been performed previously, and for about half of the 325 reading tasks cited by the sample of 178 personnel, additional reading related to the task had been performed, and for two-thirds of these cases, the related reading helped in reading the material cited in the interview. (See Sticht, Fox, Hauke, and Zapf, 1977, for a more complete description of this work).

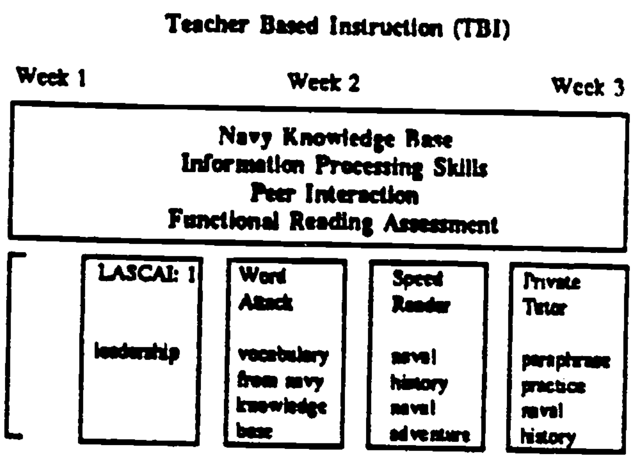


Figure 4.2

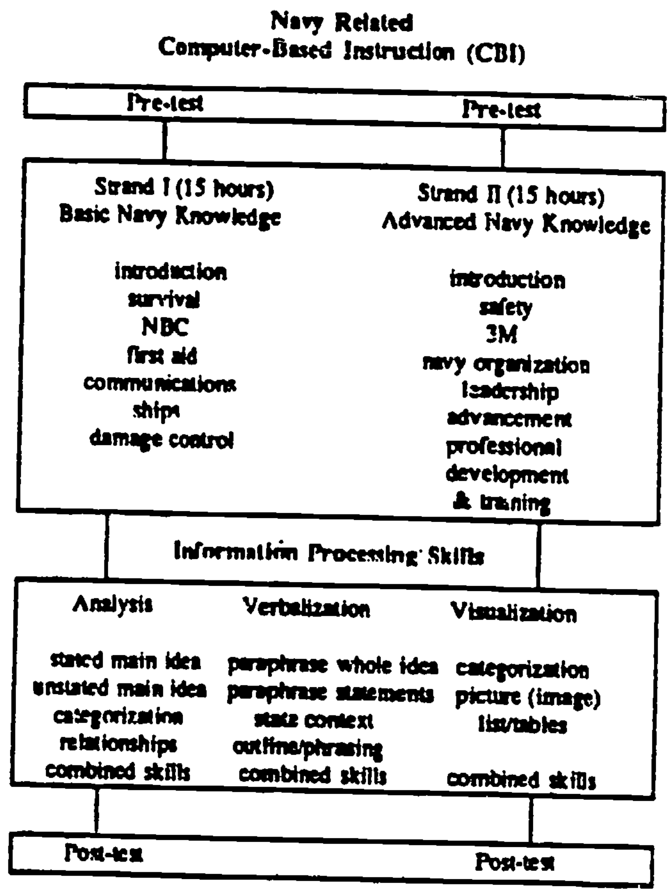


Figure 4.3

The Career Progression Reading Program

On the basis of the foregoing research and additional study of the reading demands of the Navy environment, we have designed and developed a reading program that has a functional context for Navy personnel in that the program uses Navy content derived from materials they must study to pass promotion tests, and the information processing skills are of immediate use to them. Most of the students are "mid-level" literates, with reading skills in the sixth to tenth grade levels, and most have had one or more years of duty, and so they are able to relate their knowledge base to the content of the course.

The instructional program is designed to be delivered either by a teacher using paper-and-pencil materials and peer instruction in a classroom, or by a teacher, paper-and-pencil materials, peers, and computers in a classroom, or in a learning center using computer-based instruction alone. Figure 4.2 shows the teacher-, book-, peer-, and computer-based instructional classroom delivery system that is the central model for the delivery system. The basic course is three weeks in duration and students attend for three hours a day for a total of 45 hours of instruction (the time for instruction was specified by the Navy Campus office). The books include a special reader, which, based on the model of Figure 4.1 we call a Navy Knowledge Base. This reader contains extracts and revisions from the technical manuals that personnel must read and learn from to pass promotion tests or perform higher level duties. The contents were selected because they contain the information that is on the practice tests in the manuals and are deemed important by the Navy management.

The second book is called the Information Processing Skills book, and it is modeled after the processing skills component of the model cognitive system. This book presents lessons and practice in performing various processing skills for reading-to-do and reading-to-learn tasks using the Navy Knowledge Base book. The goal here is to present externally a knowledge base and processing skills to serve as didactic tools for talking about the internal knowledge base and processing skills and to hence, make students aware of their cognitive systems and how to apply them to doing and learning literacy tasks. The Information Processing Skills book also contains tasks to be performed in peer teams. As mentioned above, this includes "higher order" analytic and communications tasks to transform prose materials into other formats, such as matrices. In the latter tasks, objects in prose passages must be analyzed through comparison and contrast to sort them into row and column defined cells of matrices. In flow charting, complex temporal tasks or events are analyzed in prose format and transformed into flow charts. Peer teams then explain their analytical products to the teacher and class, performing yet another transformation. This "representation transformation" activity permits a more thorough comprehension of complex textual materials, and it helps students learn the content knowledge that they work with.

The computer based instruction consists of public and private domain programs that serve as sort of "electronic worksheets" that the teacher can assign students to do while he or she works with other students on a small group basis. The computer software was selected to permit the teacher or curriculum specialists to personalize the instruction, and so each program has an editor feature that permits one to enter content words or paragraphs for the specific literacy domain they wish to teach. The Lascai, Word Attack, and Speed Reader programs all have a game format that operates automatically on the content that is edited into the program. The Private Tutor is sold by IBM and is a very inexpensive, easy to use authoring system for preparing individual lessons or entire computer-based instructional courses.

Figure 4.3 shows the computer-based instruction that has been developed for use in a learning center as a stand-alone, self-paced instructional program. The program has two strands, each providing about 15-20 hours of instruction depending upon the reading skill level of the user. The Strand I material contains content appropriate for sailors seeking promotion to lower level supervisory positions, while the Strand II material is primarily for those seeking higher level promotions (these are only approximations, since some contents are useful across the board in both strands).The bottom part of Figure 4.3 shows the processing skills taught in both strands of the computer-based instruction.

Functional Reading Assessment Battery

In addition to the functional, Navy-related, standardized teacher-, book-, and computer-based instructional programs, we have also developed a new reading test battery to test Navy-related reading (reading-to-do, reading-to-learn, and Navy Knowledge). The latter, that is knowledge gained, is rarely measured in reading programs because reading is considered as a content-free, process skill. But the cognitive model of Figure 4.1 makes clear that knowledge of what one is reading is required to make reading comprehension possible. So we are assessing the improvement in knowledge as a function of participation in the functional reading program. Figure 4.4 summarizes features of "traditional" reading tests and our new "functional" reading battery.

An Evaluation Study

In a small evaluation study, the improvement of a sample of students who took a "general" reading program offered by education contractors was compared to the improvement of students in our "functional" reading program on three tests: a general reading test that gives grade levels of performance, our Navy reading-to-do test and our Navy Knowledge test (the reading-to-learn test was not available at this time). The results are summarized in Figure 4.5. The data show that, in general, people tend to learn what they are

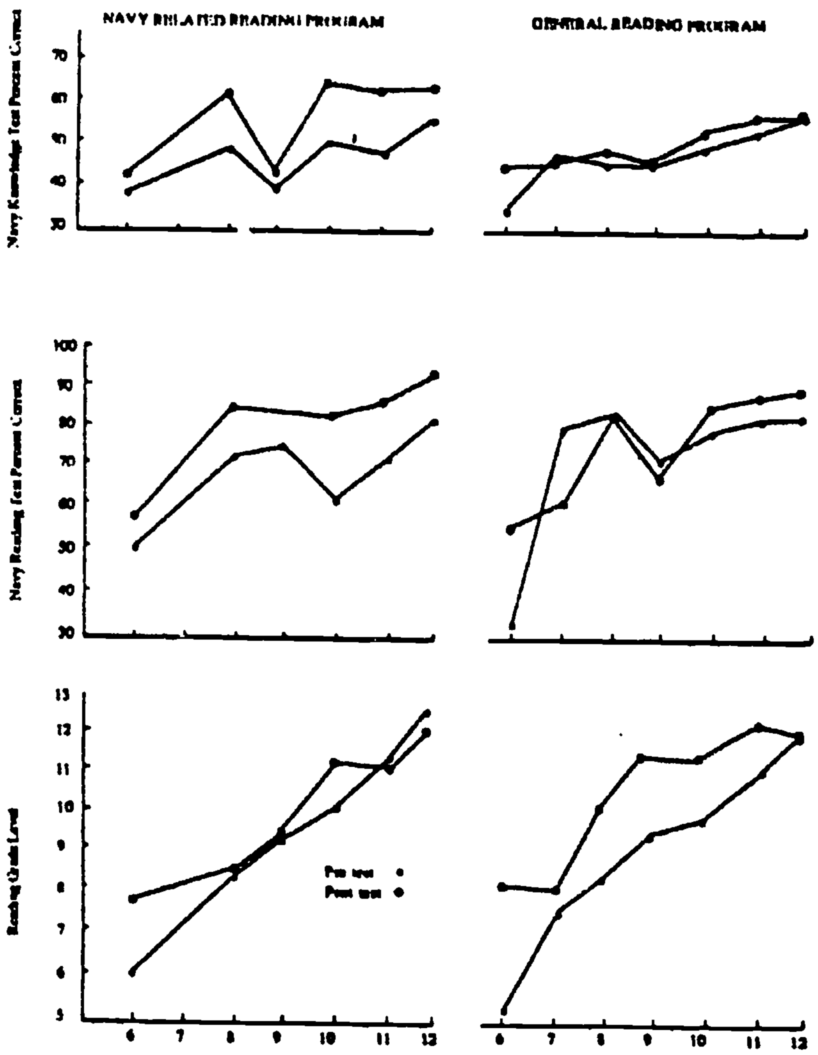
Experimental Functional Skills Program
Reading Assessment System

Current System	New XFSP System
Elementary & secondary School-oriented	Navy Career Progression-Oriented
Normed on school children	Normed on adults
Based on NO curriculum	Based on Navy-related, Standardized curriculum
Reading Grade Level Scale	Rasch Item Scale of Reading Ability
Non-equivalent forms	Equivalent forms
Skills oriented	Scaled to be comparable to California Adult Student Assessment System (CASAS)
	Skills and Knowledge-oriented:
	Reading to do Reading to learn Navy Knowledge

Figure 4.4

taught. The "general" reading program did better on the general reading test, but this did not transfer to the Navy reading and knowledge tests to any significiant degree. The Navy-related reading program, on the other hand, resulted in only a little improvement on the general reading test, but made consistent improvements where it counts for Navy personnel, that is, in their Navy reading and knowledge.

The foregoing offers support for the knowledge ased approach that is being followed in the XFSP/Reading program for the Navy. It makes the point that background knowledge facilitates reading comprehension. This is important when adult literacy programs aim to provide literacy competence in limited domains, such as work-related literacy training. These findings, and this approach suggest that both more generally useful information processing (reading and communications) skills can be developed within the contexts of content materials. The information processing (literacy) skills do not have to be acquired prior to education or training in a functional domain. Rather, both content knowledge and literacy skills can be developed together. And, both contribute to improved reading comprehension.



Entry Scores on the Gates MacGinite General Reading Test
(in reading grade levels)

Figure 4.5

Pre- and Post-Test Scores on General Reading Tests for a Navy-Related Reading Program and a General Reading Program

Knowledge-Based Readability Analysis

With the new Navy Knowledge test, we have been able to develop a new approach to estimating the reading grade level of Navy materials taking into account the knowledge of Navy materials that people who are expected to read the materials might have. This approach is based on the cognitive system model that points out that reading comprehension requires prior knowledge of what is being read. This notion has been applied earlier to readability formulas by Bormuth (1985), but has generally been ignored in other applications.

In the present work, Navy personnel were administered the new Functional Reading Assessment tests. Then they were divided into quartiles in terms of their scores on the Navy Knowledge subtest. For each quartile, separate readability formulas of the traditional type, using word and sentence length factors, were developed. Then these formulas were applied to the passages in the reading-to-do and reading-to-learn tests. Additionally, the Flesch-Kincaid readability formula was applied to the same passages. The latter is the officially prescribed formula for use in the Navy.

Figure 4.6 shows the results of the readability analyses. The solid line at the top of the figure labeled Flesch-Kincaid shows the estimated reading grade level needed to comprehend the passages when background knowledge is not considered. The left-hand bar graph shows the estimated reading level for people with very little background knowledge as measured by the Navy Knowledge test. As indicated, it matches the Flesch-Kincaid formula closely. However, as the amount of background knowledge increases from low to high, the estimated reading grade level needed to comprehend the passages at 70% correct drops rapidly until, at the highest background knowledge level, the estimate is that a 6.0 reading grade level of general literacy.

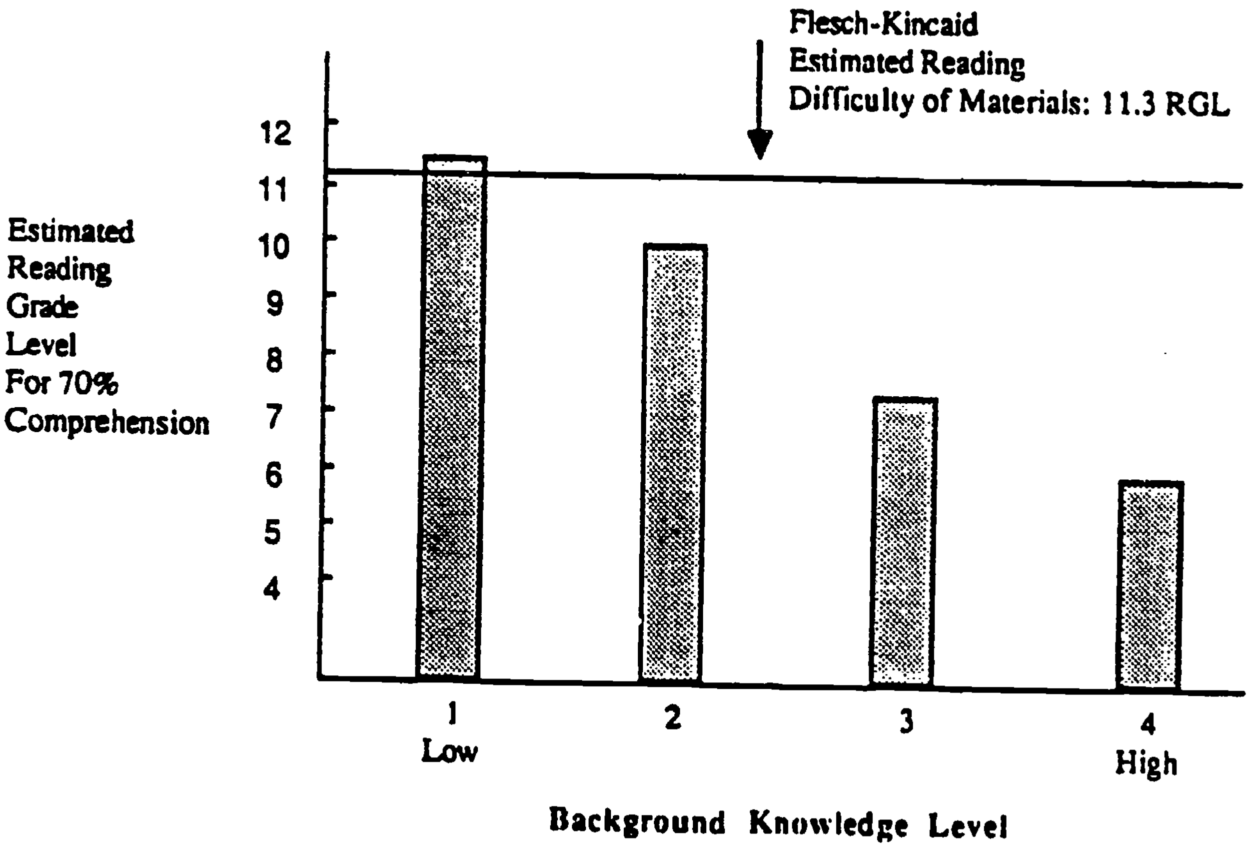


Figure 4.6

Change in the estimate of reading skill needed to comprehend at 70% correct as the amount of knowledge related to the materials increases.

XFSP: MATHEMATICS

The following is extracted from the students "Information Processing Skills" book used by Navy personnel in the mathematics course. As with the XFSP: Reading program, the Information Processing

Skills book is used with a Knowledge base book called "Mathematics for Career Progression: A Navy Knowledge Base." Also like the XFSP: Reading Program, the Mathematics program uses a combination of teachers, books, computers, and peers to deliver instruction. This permits the course to be taught by teachers, books, and peers only in sites where there are no computers. Also, in remote sites, such as submarines, the use of computers as stand-alone instructional delivery systems is possible.

In this course you will learn how to:

1. Read and comprehend Navy texts that include the use of mathematics.

2. Identify the kind of mathematics knowledge needed to perform Navy tasks.

3. Perform mathematics computations more efficiently.

4. Communicate information about Navy resources using tables, figures, and graphs.

This book, the Information Processing Skills text, is used with another book, Mathematics for Navy Career Progression to give you experience in performing Navy tasks that involve the use of mathematics in managing Navy financial, material, and human resources. The goal of the course is to prepare you to better manage personal resources and, most importantly, to prepare you to perform the leadership, supervisory, and management tasks that you may sometimes have to perform in the Navy (or in many civilian positions) if you wish to become a supervisor or manager.

Mathematics for Navy Career Progression

The primary goal of this program is to prepare you to better perform the kinds of Navy tasks that require you to use mathematics as you progress in rank and responsibility. To help achieve this goal, the course is based on the Navy Rate Training Manuals that all Navy personnel must study to take the tests required for advancement in rank.

Basic Military Requirements	Petty Officer 3	Petty Officer 2	Petty officer 1	Chief
E1,2,3	E4	E5	E6	E7

↓

Mathematics for Navy Career Progression

These Navy Rate Training manuals were used to develop the text on Mathematics for Navy Career Progression that includes Navy tasks that require the use of mathematics for their performance. These tasks were grouped under three headings:

- mathematics and financial resources
- mathematics and material resources
- mathematics and human resources

These areas of supervision and management into which you will advance as you progress in your Navy career provide an opportunity for learning or improving mathematics knowledge and for applying this knowledge to the performance of Navy tasks. The goal is for you to actually be able to use your mathematics knowledge to perform important jobs, not simply to pass a test in a school course.

The Three C's: Comprehension, Computation, Communication

This course takes an information processing approach to mathematics. This means that attention is given to how people process information that is used in performing tasks.

The course emphasizes three kinds of processes that are involved in performing Navy mathematics tasks: comprehending what the task is, performing computations that are needed to perform the task, and communicating your work to yourself and to others.

INFORMATION PROCESSING

COMPREHENSION ⟶ COMPUTATION ⟶ COMMUNICATION

Comprehension. From much research and experience in mathematics education, we know that before you can perform a task correctly, you must first comprehend what it is that you are to do. In this course, it is necessary to be able to read and understand this book and the Mathematics for Navy Career Progression text to learn what the Navy context is that you are working in, what the task is that you are to perform, and how to perform the task. Reading and understanding these books is information processing to comprehend what to do.

Research shows that difficulties in performing math tasks are often related to lack of reading comprehension as much or even more than performing math operations. There are various ways to improve comprehension. One way is to use an information processing strategy that requires activity before, during, and after a reading task.

Reading should be approached as an ACTIVE, not a passive process. More learning occurs when a reader uses active methods to help move new information into his/her memory system. This view of reading as a process may be seen as three stages of activities:

PRE-READING ⟶ READING ⟶ POST-READING

Some reading experts believe that what is done during the pre-reading stage has a crucial impact on comprehension. Just as a ship makes careful preparations before getting underway, a good reader gets his mind ready to undertake a reading task.

ERIC

The PQ3R Method

One way to help make reading an active process is to follow a pattern or set of guidelines which can be applied to many reading situations. (Within a military environment, there are times when "forgetting" crucial information could mean loss of life!)

The PQ3R method is a systematic learning strategy which helps you to make your reading "active." The steps are as follows:

P = Preview: The very important first step is to survey the material as a whole. Skim through and notice all titles, section headings, visuals (pictures, tables, diagrams), and any italicized or highlighted words. This process helps to get your mind "warmed-up" and ready to receive—similar to the way athletes warm-up before a contest.

Q = Question: Ask yourself, "What do I already know about this topic?" Take advantage of the many pathways in your long term memory to link up to prior knowledge. This makes learning easier! We know that comprehension depends upon both what's on the page and what's in the reader's head.

Next, ask yourself "What will I need to do with this information after reading?" Establish a purpose for your reading. What are your objectives: pass a test, fill out a report, perform a procedure? If possible, before you read, preview the specific tasks you will need to complete afterwards. Another approach, when studying a chapter in a text, is to turn each section heading into a question!

R = Read: Read with your objectives in mind and to answer questions. If possible, underline or highlight important ideas and key words. In situations where you can't make any permanent marks on the material, use a pencil to make "checks" in the margin to flag areas with data you want to remember. From time to time, "monitor" your comprehension—did you understand what you just read? You may need to refocus your attention or "debug" a problem by looking up the meaning of an unknown words or asking someone to clear up a confusing area in the text.

R = Recode: You are now at the post-reading stage. You should be ready to perform the tasks needed to achieve your objectives. It's important that you actively do something with the information in order to transform or "recode" it. This is the processing which makes data storable to long term memory.

R = Review: The final step, as the name indicates, is to "view again" the material covered. You may want to reduce or condense information even further into an outline, a summary or list of key terms. If you completed a set of questions, get feedback on your answers. Look back through the material and re-read the section headings. This last step helps to "pull things together" and reinforces your ability to recall information later.

The PQ3R method should not be regarded as a rigid system. You need to adapt it to your specific needs in specific situations. At first, applying this or any other learning strategy may seem like more work; however, research indicates comprehension improves and over all study time is reduced. A similar approach was used to rush men through training courses during wartime. The important idea to remember is that reading should be an active process!

Computation. While reading to comprehend what to do, you will have to identify the kinds of mathematics knowledge that is required to perform various tasks. This mathematics knowledge is used in

processing information that involves computing with numbers. In this course you will learn a simple way to organize the mathematics knowledge needed to perform the Navy mathematics tasks performed by Petty Officers and Chiefs. By better understanding what you already know about mathematics, it should be easier for you to identify what kind of math knowledge you need to perform Navy tasks, and to learn new mathematics knowledge.

MATHEMATICS KNOWLEDGE		
(1) Basic Operations	**(2) Types of Numbers**	**(3) Systems of Measure**
Addition Subtraction Multiplication Division	Whole Numbers Fractions Decimals "Mixed" Numbers Signed Numbers (+ -)	U.S. Standard/Metric Length Time Area Temperature Weight Money Volume Percentages Ratios Proportions
	(4) Descriptive Statistics: Count Distribution Central Tendency Tables/Graphs Variability	
	(5) Algebra Geometry	

The mathematics knowledge that you will use in this course is organized into five areas. Three of the areas are the core of arithmetic: basic operations, types of numbers, and measurement.

The basic operations are addition, subtraction, multiplication, and division. These four operations are used with three kinds of numbers: whole numbers, fractions, and decimals. These numbers may be positive or negative in sign, and sometimes "mixed" numbers are used, such as 1-1/2 (which is a whole number "1" and a fraction "1/2").

The numbers that are used in performing Navy tasks are always used with some system of measurement. For instance, adding two months' pay uses the money system. It is called a "system" because there are different parts (such as pennies, nickels, dimes, etc.) and they relate to each other "systematically," that is, according to well defined rules. For instance, 10 pennies added together make one dime. Ten dimes make a dollar, and so forth. Systems of measure are needed to understand and use basic aspects of the world

around us: time, length, weight, temperature, etc. For instance, if you need a rope that is 10 yards long, but the one you have is 28 feet long, then you know you need two more feet of rope. This is because in the U.S. customary system, there are three feet in each yard. (3 ft./yd. x 10 yds. = 30 ft).

In general, then, you possess mathematics knowledge that lets you perform basic operations on three types of numbers that are used in various systems of measurement.

Many times Navy tasks require that you use a system of measure in which you represent data as ratios, percentages or proportions. For instance, you may have to find out the percentage increase in food costs (a money system) from one month to the next if you are managing a CPO Mess. You, therefore, need to have knowledge of ratios, percentages, and proportions as part of your knowledge of systems of measure.

Another type of mathematical knowledge is descriptive statistics. Statistics are numbers used to describe groups of things, such as people. For instance, if you live aboard a ship that houses 1,500 personnel, "1,500" is a statistic—a count of how many people live on the ship. If they weigh, on the average 165 pounds, "165 pounds" is a statistic—the average of personnel weight.

Statistical information is sometimes put into tabular formats (tables) and sometimes into figural (graphs) formats. Your mathematics knowledge must, therefore, include knowledge about how to compile and compute common statistics, and how to comprehend and construct tables and graphs.

Communication. In addition to comprehending and computing, the third "C" that this course focuses on is communication. More and more, as you progress upward in your career, you have to communicate information to others. Supervisors have to communicate to the people who work for them, and they have to communicate to their own managers. Whenever financial, material, or human resources must be managed and accounted for, it is necessary to be able to comprehend, compute, and communicate the results of your information processing to others. In dealing with mathematical data, it is necessary to know how to gather, organize, and present data in tables, and graphs of different kinds. This course emphasizes the communication of quantitative information as a skill for Navy career progression.

Sometimes you need to communicate with yourself when performing complex tasks. For instance, read the following information on Math Problem Solving Tips and notice the steps that require you to circle something, or transform text to diagrams, or create a number sentence, and so forth. These kinds of activities are ways of communicating with yourself so you can solve problems better!

Math Problem-Solving Tips

1. READ the problem carefully! (Two or more times.) (It can help to read aloud and to try to restate the problem in your own words.)

2. Circle or list the facts given. (What is known.)

3. Underline or list the main question to be answered. (What is unknown or what is to be found.)

4. Transform the text into some other form: a drawing or diagram, a table or chart, a list, etc.

5. Organize the known data: add labels to the drawing; fill-in the table, etc.

6. Create a number sentence or set up an equation or use a formula: $X = a + b$ $A = l \times w$.

7. Decide on a process: add, subtract, multiply, or divide.

8. Do the computations in the correct order needed to solve the problem. Check the accuracy of your arithmetic!

9. TEST your answer! Does it make sense? Add the unknowns to the problem and work backwards. Did you use all the facts?

Other Approaches:
- Estimate
- Simplify by substituting smaller, easier numbers for the ones in the problem.
- Look for a pattern
- Work backwards

In performing Navy mathematics tasks, the ability to communicate is needed for two reasons. First, you need to be able to communicate with yourself as a problem solver and job performer. You need to comprehend what you should be doing, what information you need, and what your goal or objective is. You also need to know what kinds of mathematics knowledge to use for the computations that the task requires. And, you need to know how to make lists, tables, and figures to help yourself solve problems.

The second reason communication ability is needed is so that you can communicate the results of your work to others. You need to know how to make line graphs, bar graphs, and pie charts to summarize information for others. You need to know how to gather data, organize it, and present it in formats which help others to understand.

This course teaches you how to communicate better with yourself to solve math problems, and to communicate with others to inform them about your work. Both types o :ommunication are important for Navy career progression, and for success in civilian careers, too.

CHAPTER FIVE

FCE CASE STUDY #3: A FUNCTIONAL CONTEXT ELECTRONICS TECHNICIAN'S COURSE THAT INTEGRATES BASIC SKILLS AND BASIC ELECTRICITY AND ELECTRONICS EDUCATION

In both the Army's FLIT and the Navy's XFSP programs, personnel receive basic skills training in programs that are separate from the job technical training programs themselves. In this chapter, we discuss a project to develop a votech course that fully integrates basic skills and technical skills education and training. By this I mean that the teaching of reading and mathematics (and some other, higher order, critical thinking) skills is intermingled with the teaching of the technical content as an integral part of the votech course. Students do not attend separate basic skills courses to be brought up to standards. Rather, the course is designed to bring in people reading around the fifth grade through ninth grade levels (mid-level literates) and teach them both basic electricity and electronics and basic skills.

Following is a summary of work on a project called Cast-Off Youth: Policy and Training Methods from the Military Experience (Sticht, Armstrong, Hickey & Caylor, 1987). The project examined how the Armed Services have approached the training of lower aptitude, "functionally illiterate" young adults over the last half century. Based on the review of numerous research projects, the "functional context approach" to education and training was formulated to summarize the major principles that seemed to us to provide an overarching point-of-view about how to develop sound education and training for a wide spectrum of abilities. It is this set of principles, this conceptual framework, that we call Functional Context Education.

CAST-OFF YOUTH: POLICY AND TRAINING METHODS FROM THE MILITARY EXPERIENCE

Analyses of large-scale social programs concerned with youth unemployment and unemployability have generally omitted the role of the military as an "employer" of disadvantaged youth, and as an innovator in the development of education and training programs for such youth. Consequently, human resources policy and educational practice is largely uninformed by the largest data base regarding the employability and trainability of that segment that makes up what is variously referred to as the "low aptitude," "functionally illiterate," or "at risk" youth and young adult population.

Project 100,000

In 1983, the Ford Foundation sponsored a two-year study to understand the role of the military in employing and rendering more employable the cast-off youth of our society. The study took as a point of departure a highly controversial project that occured in the midst of the Vietnam War and the War on Poverty. Called Project 100,000, this publicly announced foray of the military into social action programs provided a jumping-off place for a broader view of just how the military has gone about examining, selecting, assigning to jobs, training, and utilizing that "one-third" of our Nation generally considered untrainable and unemployable.

A unique aspect of the project was that, in addition to secondary data and report analysis, synthesis, and reporting, the research team took the first step from "theory" to "practice" toward the development of a new form of job training which aims not just to render trainees employable, but to increase their general employability. Based on a set of principles developed by Project 100,000 management, grouped under the general rubic of the Functional Context Approach, the research team developed a prototype Electronics Technician's course especially designed to accommodate less literate youth and females with less technological literacy in their backgrounds. The course integrates the teaching of basic electricity and electronics with the teaching of the basic skills of reading, writing, and arithmetic.

Training for "Cast-Off Youth"

Beginning in World War II, through Korea and Vietnam, and to the present, the military services have conducted research to develop methods of more effectively training and educating personnel across the spectrum of aptitude. When reviewed with respect to the contributions of this research to Project 100,000, major findings were that:

- Factors affecting the training and successful utilization of Project 100,000 personnel included (1) the use of limited assignments of these personnel to jobs; (2) provision of extra help and time to personnel of all aptitude levels; (3) making limited revisions to training courses to reduce the difficulty of materials and subject matter; and (4) providing remedial literacy training (though evidence suggests that the latter played only a minor role in the success of Project 100,000.)

- Project 100,000 management recommended five principles for the revision of training courses for Project 100,000 personnel.

  (1) Design training objectives that are job related.

  (2) Relate learning activities and methods to specific military situations.

  (3) Identify probable areas of difficulty for lower aptitude personnel and revise them.

  (4) Integrate literacy training into technical training.

  (5) Relate initial instruction to what a person already knows.

Research related to the Project 100,000 training design guidance was reviewed with special attention to a body of research on functional context training. This research included seven major projects to develop functional context technical training, and four projects to develop functional context literacy training.

- Functional Context Technical Training. All of the projects incorporated four of the five recommendations in the Project 100,000 guidance, with the one exception being the direction to integrate literacy with technical training. Without exception, the seven projects produced courses superior to the "conventional" courses with special emphasis on the needs of average or lower aptitude learners.

- Functional Context Literacy Training. Repeatedly, studies in the military have indicated that brief, remedial literacy programs of general literacy training make only minimal, if any "real" improvements in students' literacy skills. Where significant improvements in useful competence have been demonstrated, say in performing military-life reading tasks, the

instruction has not been academically oriented, but rather the contents, materials, and tasks have been developed to incorporate the functional concepts and practices of military life, training, and job requirements. This has been true from World War II to the present.

Though the groundwork has been in place in the military for some time now, no research or operational programs were found that reported a fully integrated basic skills and job technical skills program. During World War II, Project 100,000, and at the present time, all military basic skills programs have been and are add-ons to the training "pipeline" or duty day.

Recommendations. The major legacy of Project 100,000 for training and education is a set of principles, with partially worked-out examples illustrating how to apply the principles for the design of instruction. We have called this set of principles the Functional Context Approach. In applying these principles to instructional development one provides a functional context that facilitates learning in the course, and transfer to settings outside the course.

To facilitate learning, functional context programs:

1. Let students know what they are to learn and why in such a way that they can understand the purpose of the training or education to their lives.

2. Develop new knowledge on the basis of old knowledge that the student has on entry into the program.

3. Develop new lessons on the basis of old lessons so that the new learning builds on prior knowledge.

4. Integrate instruction in "basic skills" such as reading, writing, and arithmetic into the technical training or academic content area courses to permit students to better negotiate the requirements for these skills in the program at hand, and permit them to transfer such skills to other, related settings.

To facilitate transfer, functional context programs:

5. Derive objectives from an analysis of the knowledge and skill demands of the situations for which the course is supposed to be providing human resources.

6. Utilize, to the extent feasible, contexts, tasks, materials, and procedures in the course taken from the setting that training and education address.

These six principles, so common sense in concept are so frequently abused in practice that they might well be used by program and textbook developers as checklists for guiding program design, and by program evaluators for judging the adequacy of education and training programs, particularly for youth cast-off from the mainstream of education and employment.

A Functional Context Electronics Technician's Course

The design, development, and evaluation of a prototype technological course was accomplished to illustrate how the Functional Context Approach might be applied to instructional development. The course developed was a prototype Electronics Technician's course that was based not only on the review of the military training research, but also on review of studies from the cognitive sciences on the role of knowledge

in the electronics technician's performance, and the interrelationships among literacy and technical knowledge and skills. Findings from this review indicated that:

- Expert electronics technicians draw as much on their understandings of equipment as functional systems as they do on traditional basic electricity and electronics theory. Yet the understanding of equipment is not typically taught in training programs.

- Basic skills (literacy, mathematics, problem solving, troubleshooting) are interrelated capabilities that draw upon a common knowledge base in a person's mind or "cognitive system." Hence, improvements in basic skills can be accomplished by improving student's knowledge in a domain area; this knowledge can then be used by the basic skills. This integration of the human cognitive system explains, at the level of cognitive science, why technical training and basic skills training can be integrated in instructional practice.

Other sources of information used in designing the functional context training electronics technician's course included current programs for training disadvantaged youth, such as the Job Corps, community colleges, etc., and businesses and industries that hire technicians. Major findings from surveys of civilian training programs were:

- As in the military, civilian organizations tend to sort people into training programs that their literacy skills (aptitude) "suit" them for, rather than encouraging additional education in basic skills or redeveloping training to accommodate and then develop basic skills of entering students.

- As in the military, civilian organizations tend to teach basic skills as prerequisite, "front-loaded" programs for entry into technical training, thus increasing the amount of time people must commit to training, and sometimes leading to attrition from training.

- As in the military, organizational requirements tend to "drive" educational practice. Just as the requirements for expediting people through training may lead to improper reports of "success," the fact that the performance criteria for programs funded under the Jobs Training Partnership Act emphasize job placement more than job training and general education suggests that students are likely to be screened for "aptitude" and counseled into training they can handle, with lower priority on overcoming educational deficiencies.

- As in the military, many basic skills programs that are referred to as "functional" are often just traditional basic skills programs with a few occupationally related words or mathematics problems embedded in them. Neither literature review nor program survey revealed a single instance of a totally integrated basic skills and technical training program.

Regarding the survey of industry, including employment agencies for the electronics industry, it was found that:

- Employers and employment agency personnel emphasized skills in problem solving (including but not limited to troubleshooting) mathematics, and literacy, along with basic electricity, and electronics knowledge as desirable in new employees.

Based on the foregoing, an experimental course for electronics technician's training was developed.

A FUNCTIONAL CONTEXT TRAINING ELECTRONIC TECHNICIAN'S COURSE

This section describes the main features of the prototype Electronics Technician's course that was developed based on concepts from functional context theory. The Functional Context Training Electronics Technician's (FCT/ET) course was designed to help marginally prepared students succeed in a full-scale Electronics Technology training program, one in which they might otherwise fail. The FCT/ET course attempts to facilitate learning in three ways. First, it builds new knowledge on old knowledge by using familiar electrical devices to teach basic electronics principles and equipment analysis procedures. Second, for each electrical device, the sequence of instruction proceeds from active manipulation of the device to see how it and its subcomponents function, to study and construction of block diagrams of the device and/or its components, and then to the performance of reading and mathematics tasks involving knowledge of the device. Third, the content of individual lessons and the sequence of their presentation are explicitly constructed to permit students to transfer what they have learned to other training or job settings.

It should be noted that the program described herein is meant primarily to illustrate what a functional context program that integrates basic skills and technical training might look like. It is not a complete electronic technician's course. Rather, the prototype program includes materials for some 90 hours of instruction (6 hours per day, 5 days a week, for 3 weeks) that could serve as preparatory training for students with literacy skills in the fifth through the ninth grade range. This range includes some 47% of the youth and young adult population, according to Department of Defense data of 1980 (Sticht, 1982, p. 11).

Design of the Course

The design of the FCT/ET's course followed the broad conceptual guidance of the model of a human cognitive system discussed in Chapter 2. According to the developmental model, the human cognitive system includes a knowledge base that contains the person's accumulated knowledge of the world and how to operate in that world using the information available in it. The knowledge base contains a subset of knowledge called the information processing skills. These processing skills operate on information from the knowledge base and from "outside the head" in an active "working" or "short term" memory. Thus, for people to learn, new knowledge must be integrated into old knowledge via the information processing skills.

The cognitive system model was used heuristically to help the development team focus on the curriculum as a means of "designing the mind" of an electronic technician, rather than the traditional focus on teaching basic electricity and electronics. The latter focus tends to lead to abstract, decontextualized subject matter programs that may or may not provide the knowledge and skill actually required by an ET at work. The cognitive model continually focused attention on the question of what an ET must really know to learn and to do a job.

The curriculum operates under the assumption (and supporting research) that what makes someone a good technician is systematic knowledge about how electronic equipment works and of specialized procedures for diagnosing equipment failures, in addition to theoretical knowledge of electricity (Rouse & Morris, 1985). The curriculum explicitly aims to develop "mental models" of equipment and analytic procedures for thinking about equipment in a systematic way.

The cognitive system model graphically illustrates the interrelationships, and indeed, the interdependencies of the so-called "basic skills" of reading and mathematics and other knowledge and processing skills typically thought to be technical knowledge that is independent of the knowledge needed to comprehend what is being read. This tendency to view content knowledge as separate from whatever it is that makes

reading comprehension possible shows itself repeatedly in the existence of separate basic skills remedial courses that are supposed to prepare students with the "reading comprehension skills" that they will later need to read and comprehend the content course material. The tendency to view knowledge as compartmentalized also shows itself in the basic skills courses where reading and mathematics are taught separately, even though the reading of mathematics texts and word problems poses many of the major problems in the learning of mathematics. In the present curriculum development, knowledge was viewed in an integrated manner.

Figure 5.1 illustrates how the FCT/ET course applies the concepts of a knowledge base with processing skills. The major materials of the course are a textbook called "An Electronics Technician's Knowledge Base" and a student workbook called "An Electronics Technician's Information Processing Skills." These books were developed as external analogies of the cognitive system model of a long term memory (knowledge base) and working memory (information processing skills). Just as in the human cognitive system model information processing skills are applied to the internal knowledge base, in the instructional model, the information processing skills presented in one book are applied to the Electronic Technician's Knowledge Base text to transform the knowledge stored in the book to knowledge stored "in the head."

In the FCT/ET course, the ET's "mind" was construed as requiring knowledge in five domains: problem solving, "mental models," basic electricity and electronics (BE&E), language, and mathematics (all, of course, interrelated with other "world knowledge" not explicitly addressed in the course). Large parts of this knowledge were "packaged" in the ET's Knowledge Base volume. Additionally, information processing activities involving reading, writing, and mathematics were included in the ET's Information Processing volume. In use, students apply the Information Processing skills to the ET's Knowledge Base both to learn the knowledge and to improve their processing skills. These text-based activities are supplemented by instructor lectures and demonstrations, and hands-on laboratory work using various common-place electrical devices.

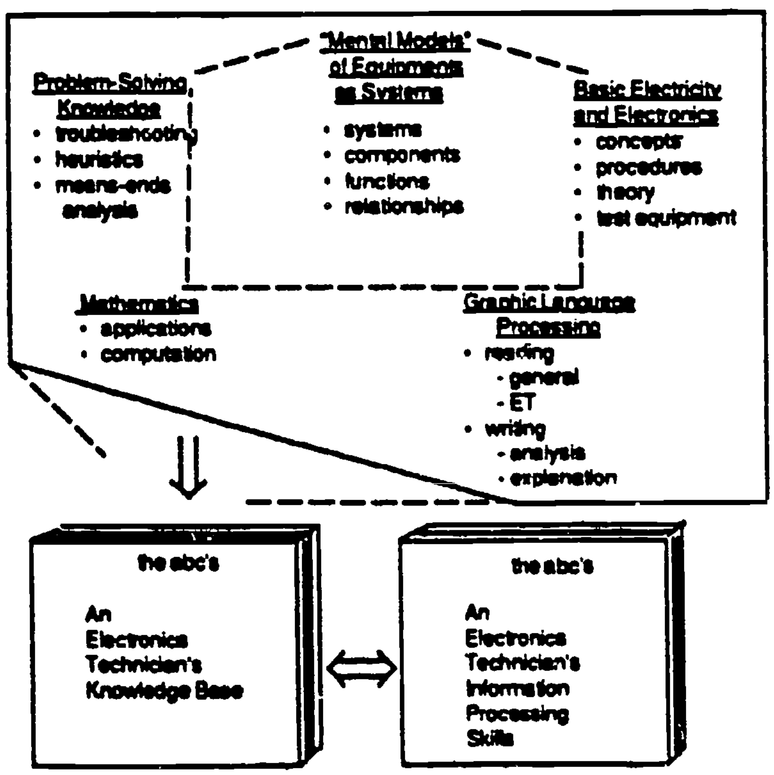


Figure 5.1

Knowledge base and information processing skills for the functional context electronics technician's course.

The general content and sequencing of instruction in the FCT/ET course are summarized in Figure 5.2.

To facilitate entry learning and build a meaningful and motivating basis for in-course learning, students at entry are given information about various jobs and additional training for ET's that they may wish to consider after the program. This is followed by an overview of the course which emphasizes the ET's role in operating, maintaining, and repairing equipment. Students are told that in the FCT/ET course they will learn how to think about equipment in a systematic way, and that they will learn this way of thinking using common, everyday electrical devices that they most likely have used in their day-to-day lives: a flashlight, table lamp, curling iron, and AC adaptor used with portable radios and tape players to recharge or replace their batteries. The pieces of equipment were selected both for their familiarity to females as well as males, and for their usefulness in introducing BE&E concepts and procedures.

By thinking ahead about what problems lower-aptitude, less literate students might encounter on entry into the course, the contents and sequence of the FCT/ET course were planned to proceed from the concrete to the abstract, from the specific to the general, from practice to theory, and from the familiar to the unfamiliar (Goffard, Polden, and Ward, 1970). This is accomplished using direct, expository prose in the ET's Knowledge Base text, avoiding analogies and metaphors that might require additional knowledge beyond that possessed by many students and not provided in the course (Shoemaker, 1960).

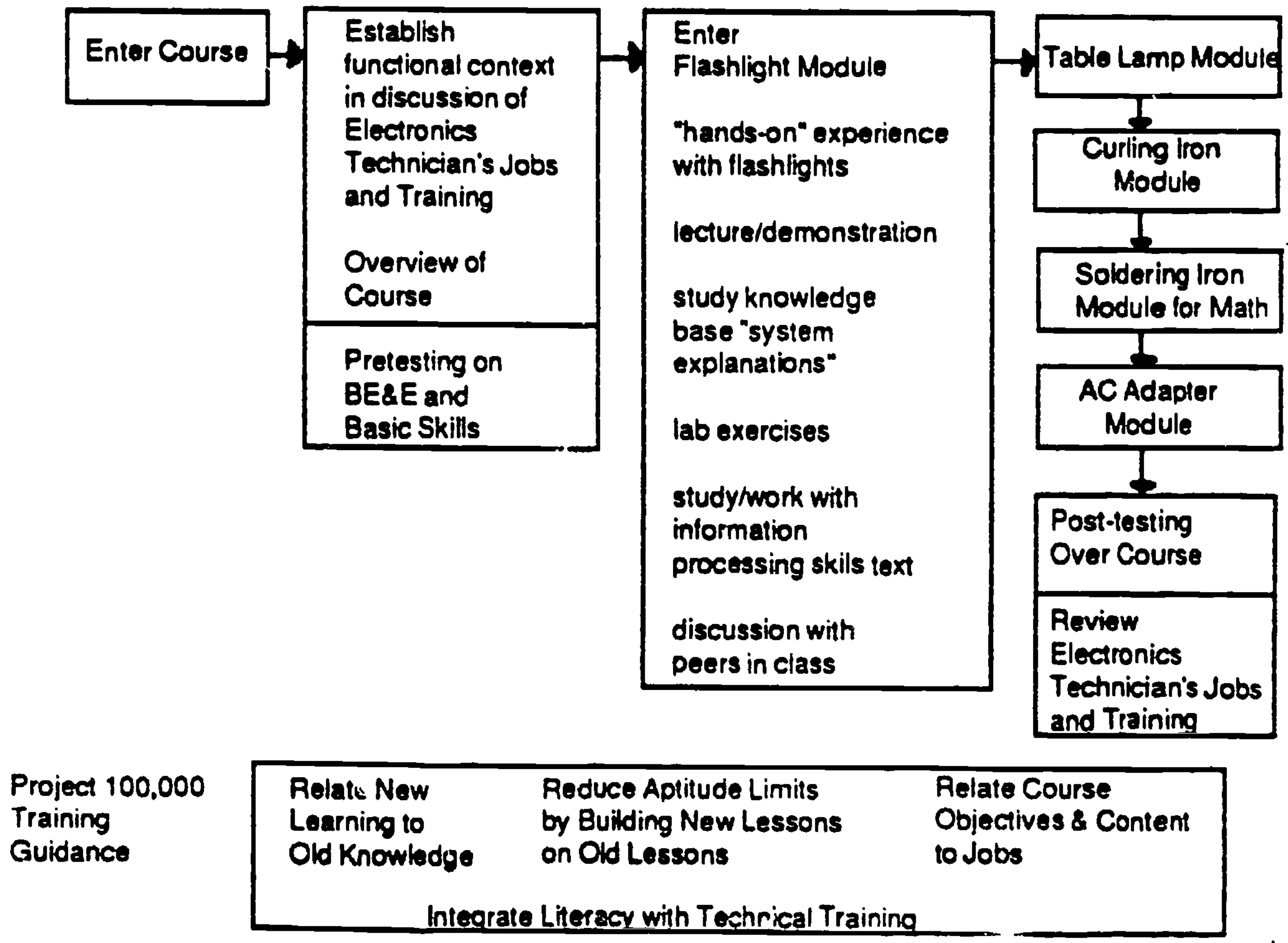


Figure 5.2

Content and sequence of instruction in the functional context electronics technician's course.

Proceeding through the course, lessons are sequenced within and across each module to build on and extend the student's knowledge base. Each module introduces a new electrical device or "equipment." The students are first given the opportunity to uncover and use whatever system understanding they already possess in attempting to troubleshoot devices that have been intentionally-faulted. To build "mental models" of equipment, students explore the devices in a "hands-on" fashion, then they listen to a lecture and watch a demonstration and work along with the instructor to learn how to examine and think about the piece of equipment as a "system" with specific inputs and outputs. Students are taught that each system includes separate subsystems, each with its own function. The subsystems contribute to the function of the whole system and all subsystems must function for the total system to function. Each subsystem may contain one or more individual circuits upon which the subsystem's function depends. Finally, the circuits (or subsystems) are made up of individual components collectively, and at all levels of complexity, the parts of a system are referred to as the elements of the system.

To diagnose and repair a malfunctioning system efficiently, students must understand the function of each of the system's elements, and the interaction among elements. This understanding is used to generate hypotheses about the location of problems. By testing each of the hypotheses, it is possible to isolate the failing element causing the malfunction. Figure 5.3 illustrates the analysis of devices from the system level, through subsystems, circuits, and components.

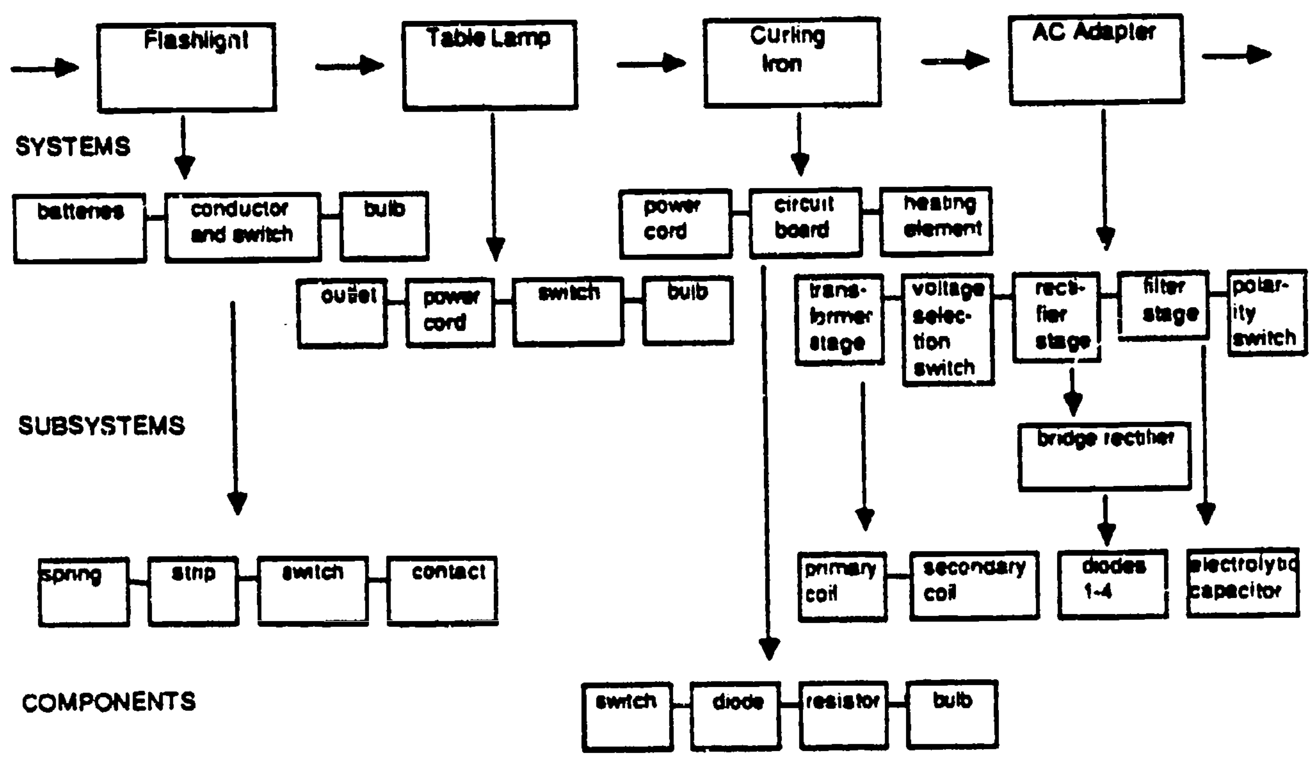


Figure 5.3

The "whole-to-part" systems analysis of electrical devices.

The curriculum proceeds "downward" through each system, in a decomposition that simulates the troubleshooting activity of an expert. This general sequence is called "whole-to-part" because it starts at the level of a whole system and proceeds to its parts.

Instructions for analyzing each electrical device are given in the ET's Knowledge Base text. The instructions for each equipment are presented in a module called a "System Explanation." Each System Explanation is essentially a text-based "narrative" with the troubleshooting of an electrical system as its "plot." Its diagrams, text, and illustrations together constitute a description of how to diagnose and repair a target system. As new elements of the system are introduced, students learn new concepts and skills needed to understand and test new functions, and to replace faulty elements. The Knowledge Base also serves as a tool for teaching reading.

Block diagrams illustrate the functions of each of the system's elements at the different levels. Figure 5.4 shows the functional block diagram of the curling iron.

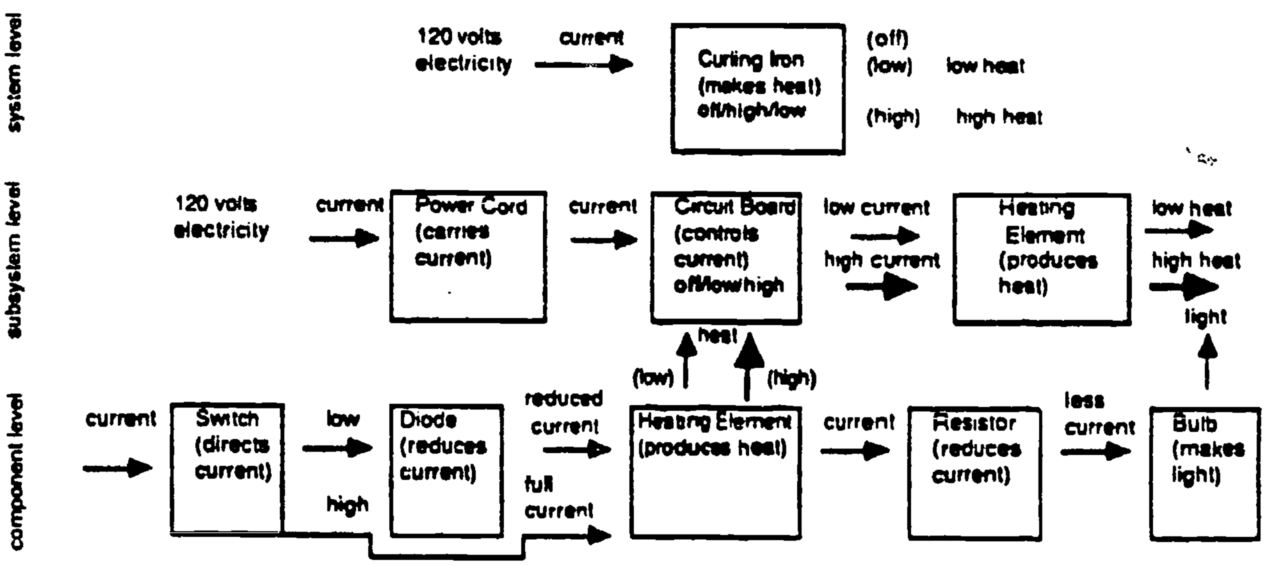


Figure 5.4

A symbolic representation of the systems and subsystems of the curling iron using functional block diagrams.

The top level of the curling iron diagram shows the function of the whole system; the input is electric current, the output is high or low heat, depending on the switch setting. The top, or "system" level of the block diagram represents explicitly the basic understanding one has implicitly when using the device. This is the implicit knowledge that most students already have (which is drawn on to begin the more formal learning of a systems way of thinking about equipment, as is needed by the competent electronics technician). The second level of the System Explanation, which corresponds to the second level of the block diagram, describes

the function and testing of the three subsystems (the power cord, the circuit board, and the heating element). The third level covers the function and testing of each of the circuit board's components.

The block diagrams make it possible to differentiate physical outputs, such as heat and electricity, and controls, such as switches and dials. Since the learners are expected to have little technical knowledge of electricity and electronics, conventional schematic diagrams are inappropriate for conveying new concepts. When a schematic is needed to further explain the circuit that makes up the curling iron's circuit board, a schematic diagram and instructions for reading it are introduced with a corresponding block diagram. Additionally, most of the elements and many of the procedures described in the System Explanations are illustrated with line drawings.

Integrated Basic Skills Instruction

In developing the FCT/ET course, reading, writing, diagramming, problem solving, and troubleshooting instruction were integrated with the technical knowledge development. As mentioned earlier, in the cognitive system model, reading, mathematics, and other cognitive capabilities are not thought of as separate abilities to be taught prior to and with materials primarily external to electronics. Rather, in keeping with the developmental model, in which cognitive development proceeds by building new knowledge on old knowledge, the basic cognitive skills instruction takes advantage of what students are learning about BE&E, and the BE&E instruction takes advantage of the student's increasing knowledge of mathematics and strategies for learning by reading.

This "integration" of literacy and mathematics training serves several purposes. First, by teaching basic skills within the context of technical course content, students can understand the functional utility of reading and mathematics concepts. Hence, they may be motivated to increase both their technical skills and their literacy and math skills. Just as technical topics are connected with student's prior knowledge, literacy, and math skills are connected with something students already know about. Second, the presentation of technical and basic skills instruction together eliminates the need for remedial courses students might need to take before receiving technical instruction. Combining the two types of training shortens total training time. This is of special importance for out of school youth and adults because it permits them to move out into the labor market sooner, and it gives students less time to get frustrated and drop out of training.

Literacy Skills

Developing the literacy competence needed to perform a wide range of job-related reading tasks is crucial to improving a student's long term employability. Performing the exercises in the Information Processing Skills volume teaches the basic literacy skills the students need in order to read training and job-related material. These exercises guide the students processing of information contained in the Knowledge Base book. Simple worksheets provide explanations of and practice in performing reading-to-do and reading-to-learn tasks (Sticht, et al., 1985). Reading-to-do tasks involve looking up information and remembering it only long enough to apply it, such as looking up repair specifications in a technical manual. Reading-to-do skills are used to extract information from documents and include using tables of content, indexes, and glossaries, and searching or scanning bodies of text, and tables and graphs, in order to locate needed information. Reading-to-learn tasks involve reading information and storing it for long term in the knowledge base for later use, such as studying for a test or learning about a piece of equipment. The specific reading-to-learn skills include re-reading something that is not understood, asking oneself questions about the material, transformation of information read by paraphrasing, block diagramming, or pictorializing the information, and focusing attention for re-reading by highlighting, underlining, or summarizing the information. These are the types of activities reading specialists usually teach to improve reading comprehension and learning by studying texts.

Applying functional context principles to literacy training suggests that material written on a topic about which the student has developed some prior knowledge will be read and understood better. Although the literacy instruction is focused on BE&E, many of the concepts and skills they acquire are applicable in a wide range of situations. For example, one of the exercises has students look up component specifications in a reference book to find information needed to replace components in the systems they are repairing. While the information they are retrieving is related to electronics, the "look-up skills" should generalize to other types of reference materials (see Sticht, et. al., 1987, for evidence showing some generalizability of literacy developed in specific domains).

Reading comprehension in the electronics area is further facilitated by the overall design of the course that begins with concrete objects (flashlights, etc.) and knowledge that the students possess. Readings build on this prior knowledge to permit the further development of the students' knowledge base in the electronics technology domain. According to the human cognitive system model, reading comprehension in a given topic area can be improved by increasing one's knowledge base in that area. By coupling this improvement in domain-specific knowledge with instruction in the general strategies for reading-to-do and reading-to-learn, it is anticipated that students will develop more generally useful literacy skills and, hence, their overall employability will be improved.

Mathematics Skills

The process of troubleshooting electrical devices generates the need for mathematics knowledge. Using the multimeter to test flashlight batteries requires an understanding of fractions in order to read the scale and an understanding of decimal numbering in order to adjust scale readings. Reading the frequency and amplitude of a waveform on the oscilloscope screen calls for a solid grasp of many mathematical concepts, including scientific notation. In general, the System Explanations in the ET's Knowledge Base introduces mathematical concepts and their application, whereas students get practice using the skills from the worksheets in the Information Processing Skills book.

A separate lesson, the Soldering Iron System Explanation, was developed to help students over what appears to be a major hurdle in BE&E training. In needs assessment interviews, instructors noted that many students have difficulty understanding Ohm's Law and the applications of its associated math skills. The law governs the relationship between the resistance, voltage, amperage, and power values in a circuit; its application calls for understanding basic algebra concepts. Understanding of the concepts and ability to apply them to circuit problems is necessary in order to complete any conventional curriculum and to function in most job-settings. Instructors cited student's difficulty with this content as justification for the rather high level (high school algebra) of math skills that are prerequisite for entry into most BE&E programs. Examination of several conventional curricula revealed that Ohm's Law is usually introduced in an abstract fashion using schematics of contrived circuits, symbolic representations of circuit values, and an assumption of extensive mathematics knowledge.

The Soldering Iron Explanation introduces Ohm's Law by showing how to calculate a soldering iron's wattage rating. While it gradually introduces the mathematics of Ohm's Law, the lesson introduces the abstract representations of circuitry that are a source of confusion for students in conventional courses. The lesson is introduced with a hypothetical job-related problem: "What would you do if you faced a task that called for a soldering iron of a specific wattage rating, and your iron rating was not identified?" The instructor then demonstrates how, after measuring the resistance in the iron's circuit with the multimeter, one can determine first amperage and then power using Ohm's Law and a few simple calculations. In the System Explanation, a pictorial representation is substituted for the actual iron and test instruments, and the same calculation is shown again.

ERIC

A gradual progression from concrete to abstract representations as more and more complex calculations are presented allows each part of the lesson to provide a functional context for the introduction of each subsequent increasingly abstract representation. Schematic drawings are gradually substituted for pictorial representation of the process; the full names of the values (resistance, current, voltage, and power) are eventually replaced with their standard symbols (R, I, V, & P); and the value units of measurement (Ohms, amps, volts, and watts) are replaced with their abbreviations (O, A, V, and W). At the end of the lesson, students are working Ohm's Law math equations using the same abstract representations with which many conventional curricula start teaching this content.

Pilot Testing the FCT/ET Materials

The Experimental FCT/ET course described above has never been fully implemented and evaluated. However, an early version of the Knowledge Base and some components of the Information Processing Skills text were used in a pilot test to obtain data about the feasibility of an integrated basic skills and BE&E curriculum and to obtain information upon which to base revisions and further development of the curriculum. At the time of the pilot testing, the experimental curriculum consisted of four System Explanations and a set of worksheets; the Soldering Iron Module was tried out in rough form.

The tryout site was a community college's Continuing Education Center. Because of its organization and funding, the Center was more able than most other vocational programs (e.g., private technical training schools) to serve disadvantaged and lower-literate individuals for whom the program is meant. The students in the Center's electronics course ranged in age from 19 to 55 and most had no formal training or experience in electronics. All Continuing Education Center Students take the vocabulary and paragraph comprehension components of the Test of Adult Basic Education (TABE). Initial screening keeps the basic skills level of the individuals in the electronics class fairly high, so that many of the participants in this pilot tryout had TABE grade level scores above 10.0. Although the FCT/ET course is ultimately intended for students of much lower literacy, many students in the previous Continuing Education Center electronics class had experienced difficulty reading the conventional technical text, and even with the initial screening attrition rates had been high. Hence, the use of the experimental curriculum to improve the performance of the present population of students at the Center was considered a reasonable first test of its effectiveness.

Outcomes

The pilot testing suggested that it is, indeed, feasible to integrate basic skills instruction into technical skills training. Although there were some minor logistical problems, it was possible to deliver the course as it had been constructed. The electrical devices (flashlight, etc.), as it turned out, had been chosen well. The reaction of students and teachers to the course and its content was, in the main, positive.

One of the main objectives for the pilot study was to determine whether or not the reading difficulty of the System Explanations was too high. Based on the students' abilities to answer questions on the quizzes, and instructors' observations, the students were able to understand the contents of the System Explanations with only moderate difficulty. This was expected, given the high reading scores of the students. The implication here is that the Explanations should provide challenging reading for the lower-ability readers (fifth through ninth grade levels) for whom they were intended, and, hence, contribute to further development of their reading skills.

All of the students were at least somewhat familiar with each of the four pieces of equipment described in the System Explanations. The students' guesses as to the possible problems in malfunctioning systems indicated that they knew how each device worked, but they did not understand it well enough to be sure of their

answers. For example, most students recognized that only one heat setting operating on the curling iron indicates a fault different from the one indicated by neither heat setting working, but they were unable to analyze the differences beyond that level. That the students understood the difference between the malfunctions suggested, however, that they had some knowledge of curling irons and of what it means to say that one does not work. It is reasonable, therefore, to use a curling iron to create functional contexts for teaching electrical repair. Similar observations held for the other pieces of equipment.

While formal data gathering was out of the scope of this partial tryout, there was clear evidence that the students were learning both BE&E and basic skills. The students were able to answer quiz questions correctly and they demonstrated the skills covered. All of the students were able to use the multimeter to measure voltage and resistance values. Although such observational data provide the same basis for evaluating student learning as is used in the various training programs surveyed, it is clear that the development of pre- and post-tests for evaluating the overall effectiveness of learning in the course would be desirable if a complete FCT/ET course were to be developed and evaluated.

SUMMARY

This chapter indicates how Functional Context Education concepts were applied to the task of instructional development.

In summary, the theoretical framework for Functional Context Education includes:

- The learner with a "human cognitive system" with an internal knowledge base "inside the head" and access to an external knowledge base in the world "outside the head." The learner has a working, or short term memory in which processing skills such as language are used to move information in and out of both the internal and external knowledge bases.

- Learning as information processing with an emphasis on the internal mental processes involved in learning and the conception of learning as an outcome of these processes.

- A developmental perspective of literacy emphasizing the development of oral language from earlier prelinguistic knowledge and literacy as the amalgalm of prelinguistic, linguistic, and graphic symbolic knowledge (see Chapter 2).

- The importance of context in learning new information and in transferring information already learned to new and different problems and situations.

The application of this theoretical framework to the instructional development process suggests creating courses that facilitate learning on entry into the course, learning throughout the course, and transfer into the contexts for which the learning is meant to apply. To accomplish these objectives, courses should be developed that:

- Explain what the students are to learn and why in such a way that they can always understand both the immediate and long term usefulness of the course content (facilitates entry into the course; motivates learning).

- Consider the old knowledge that students bring with them to the course, and build new knowledge on the basis of this old knowledge (facilitates entry learning).

- Sequence each new lesson so that it builds on prior knowledge gained in the previous lessons (facilitates in-course learning).

- Integrate instruction in reading, writing, arithmetic, and problem solving into academic or technical training programs as the content of the course poses requirements for information processing using these skills that many potential students may not possess; avoid decontextualized basic skills "remedial" programs (facilitates in-course learning; motivates basic skills learning; reduces instruction time; develops "learning to learn" ability transferable beyond the course).

- Derive objectives from careful analysis of the explicit and tacit knowledge and skill needed in the academic, technical training, or employment context for which the learner is preparing (facilitates transfer).

- Use, to the extent possible, learning contexts, tasks, materials, and procedures taken from the future situation in which the learner will be functioning (facilitates transfer).

Given that the instructional principles are rather general, the best method for conveying to others how they might be used to develop instruction would seem to be through examples. For this reason, this notebook presents three case studies illustrating how Functional Context Education principles were applied to developing work-oriented basic skills programs. In the present chapter, a study was reported in which we developed a prototype electronics technician's course which, if all went as planned, would permit the training of persons typically screened out of such courses because of low literacy or other aptitude requirements. Additionally, because the course draws on understandings of how electronics technicians who are more expert than others work, it seems likely that such a course could produce more productive technicians than do typical courses aimed at developing considerable knowledge of the theory of electronics, but little understanding of the equipment systems to which such knowledge is applied.

Though only a small scale tryout of parts of the experimental course has been accomplished, it was found that the course produced positive student attitudes and learning, and it was viewed favorably by electronics instructors and administrators. These findings suggest the need for further work to explicate the principles of Functional Context Education as they relate to cognitive development, learning, and instruction, and to apply Functional Context Education to the development of instructional programs that can address the serious educational needs of the fifty percent or so of our adult population with literacy skills below the ninth grade level and who seek better opportunities in our nation's work.

ERIC

CHAPTER 6

GUIDELINES AND METHODS FOR DEVELOPING OCCUPATIONALLY RELATED BASIC SKILLS PROGRAMS

Experience in research and operational projects to develop and operate basic skills training programs in business and military settings, such as those described in the case studies, has led to the emergence of several conceptual and procedural factors that should be considered by those wishing to work further in this area. This section discusses the need for a conceptual model of adult basic skills development, four principles for program development, and the Instructional Systems Development (ISD) procedures developed by the U.S. Department of Defense as guidance for developing basic skills or other technical training in work settings.

A CONCEPTUAL MODEL OF ADULT BASIC SKILLS DEVELOPMENT

Anyone assuming the responsibility for developing an adult basic skills program should acquire an understanding of the person as an information processor who develops new capabilities over time using prior knowledge and skills as the means for acquiring new knowledge and skills. In the basic skills programs discussed in Chapters 3, 4, and 5, reading was construed as information processing involving the combined use of fundamental psychological processes (perception, cognition), linguistic processes (phonology, grammar) and knowledge. The knowledge-based conception of reading emphasizes a developmental sequence in the acquisition of reading skills that proceeds as follows. First, early in life infants adapt to their world by means of the basic processes of perception and cognition. Eventually, in the usual case, these processes are brought to bear on the acquisition of oral language skills. The latter are typically acquired through the processes of speaking and auding (listening to and comprehending speech), or the oracy skills. Following (and sometimes along with) the acquisition of oracy skills, reading skills may be acquired if the person is in a literate society. The literacy skills consist of reading and writing and represent alternative modes of expression and reception of the same knowledge and language developed through listening and speaking. Writing is the visual form of the spoken language. Additionally, however, the graphic system permits the use of visual symbol systems like charts, tables, and figures, which demand special literacy skills for use (see Chapters 2 and 3).

The conception of literacy followed in the Functional Context Education programs emphasizes knowledge and information processing skills, including language and the more specific visual perceptual skills involved in using the written symbol system. In order for students to achieve higher levels of literacy skills through this approach, they need to achieve higher levels of knowledge and cognitive (reasoning) skills used in conjunction with language. In order for reading comprehension to occur in work settings, students need to have a body of job knowledge that can be expressed and comprehended in oral and written language. Working within the developmental framework provided a heuristic for program development that emphasized (1) relationships of oral to written language and (2) the role of knowledge of the job content in developing higher levels of reading skill.

The FCE projects were also premised on a conception of the learning process. In FCE learning is construed as an information processing activity. The information processing conception of learning emphasizes internal mental processes involved in learning as the result of an active, constructive process on the part of the learner. This differs from a strict behavioristic conception of learning in which the person is viewed primarily as a mindless emitter of responses that are shaped through the contingencies of reinforcement and whose learned responses are the result of some more or less automatic process of association among stimuli

and responses. For the FCE programs, the most important aspect of the information processing perspective of learning was the emphasis upon the active, construing nature of the learning person. This suggested that instruction should be designed to stimulate (1) active information seeking and processing, particularly of the type indicated in prior research to be important and (2) job-related functional literacy (or numeracy) skills, for example, learning how to locate information in job manuals, how to follow procedural directions in a manual, and how to manipulate text information actively to produce matrices and flow charts.

Additional discussions of adult basic skills models are found in Sticht et al. (1974) and in the many research publications concerned with reading (e.g., Pearson 1984), mathematics (Resnick and Ford 1981), and cognitive science (Sticht, Chang, and Wood 1986). The major point to be understood here, however, is that it is important for the prospective developer of a job-related reading program to have a sound conceptual model of human cognition and learning and how this knowledge can be used to develop the basic skills of adults. Such conceptual models are useful in the design of needs assessments, program materials and approaches, and evaluation techniques. They also provide a means of conceiving of th.. program development effort in an organized manner.

PRINCIPLES FOR PROGRAM DEVELOPMENT

In addition to revealing the importance of conceptual models of the adult learner in occupationally related basic skills program development, work on such programs has suggested the importance of four principles for program development: (1) maintaining an orientation to the mission of the business, industry, or government organization for which basic skills programs are to be developed; (2) providing training in basic skills within a functional context; (3) arranging program conditions to maximize active learning time; and (4) using a competency-based, mastery learning instructional approach where possible. These principles are discussed next.

Organizational Mission Orientation

Professional educators most often become engaged in the development of basic skills programs for adults in business settings. Such professionals have ordinarily been taught to regard the individual and his or her needs as the major focus of concern. However, when working within the context of a particular work setting, it becomes necessary to consider the mission and goals of the organization, be it a business, industry, or government agency, as the primary concern. The approach, then, is to determine how an effective basic skills program can be developed that will help the business or agency achieve its goals in a cost-beneficial manner. In this regard, for instance, if it can be demonstrated that basic skills and technical skills training can be integrated and both taught at a fraction of the cost of separate types of programs, then a company is more likely to become engaged in basic skills training. In this way, the undereducated person who seeks to become employed will have his or her needs best served by attending to the employer's needs during program development.

Functional Context Education

Functional context education is based on the understandings from research that skills and knowledge are best learned if they are presented in a context that is meaningful to the person. Thus, rather than teaching students who need job-oriented basic skills to read and write and compute using general literacy materials, it is better to use job reading and numeracy materials and tasks. The more similar the basic skills training tasks are

to the actual job tasks, the greater will be the likelihood that the training will pay off in improved performance of job literacy tasks. Thus, for youth and adults aiming at work in a given industry or organization, the use of job-related materials serves two purposes. On the one hand it provides a functional context for the learner—that is, he or she can see that the materials are relevant to the employment goal—and hence, motivation to use the materials is elevated. On the other hand, the organization can see that the training is relevant to its needs and that there is some likelihood of the trainees actually becoming competent in the performance of job-relevant skills. Thus, organizational motivation to participate in the training is gained. For further explanations of functional context education, see Chapter 5.

Increasing Time on Task

As indicated previously in the discussion of the person as an information processor, learning occurs best when the person is actively engaged in information processing, that is, seeking, transforming, and representing information. The principle of increasing time on task means that program developers and operators should seek to arrange the conditions of learning so that the greatest amount of time possible is spent with each trainee actively engaged in a learning task. Learning time is a much more precious commodity for both organizations and adults than for children whose main preoccupation is schooling and learning through play. Adults, on the other hand, have responsibilities that place demands on their time, such as shopping, working, and other duties associated with their multiple life roles. Therefore, whatever time is found for goal-oriented learning should be well managed to ensure that active time on learning tasks is kept at the highest level possible. Because organizations count training time against productivity, any activities that will reduce training time contribute to productivity (other things being equal). Thus, to the extent that trainees are kept actively learning, and to the extent that this results in more efficient training, then organizational functioning in the training area is improved, and the performance of the organization is improved. Through these means, increasing time on tasks contributes to both the person's and the organization's goals.

Competency-based Instruction

Competency-based instruction is instruction that is evaluated by indicators of learning rather than by indicators such as attendance, amount of time spent in training, and completion of training (though the latter indicators may be useful in addition to the indicators of learning). At a minimum, pre- and post-instruction tests should be administered to see if what is being taught is, in fact, being learned. In addition to pre- and post-tests, it may be useful to have pre- and post-module tests, where instruction has been modularized (see the Strand I modules of the FLIT program discussed in Chapter 3).

Other indicators of cognitive development may include performance checklists, student products such as a constructed array of tabular or graphic data, and instructor judgements (the latter should always be accompanied by some other, empirically-based indicators of learning). In general, some objective, convincing data should be provided to demonstrate to students, teachers, and administrators that the important learning objectives of the course are, in fact, being achieved. Success is thus defined in terms of competence achieved, rather than simply participation in a prescribed number of hours of instruction or until the student wants to quit an open entry/exit program.

INSTRUCTIONAL SYSTEMS DEVELOPMENT (ISD)

Analysis

The analysis process of the ISD system is concerned with (1) determining that a training need exists, and (2) if required, identifying what the content of training should be. Regarding basic skills training development, the analysis process should establish that an organization needs to conduct basic skills training, perhaps due to the inability to find sufficient numbers of qualified job applicants, because new technology has changed the requirements for basic skills, or some other reason. What is important is to establish that the organizational problem is due to some basic skills requirements that are not being met, rather than some other factor, such as logistical problems in obtaining supplies and materials, inadequate assignment procedures, poor management, and so forth.

During the analysis activity, the basic skills requirements of the organization's job training system (if any) and job duties should be established. This is not a straightforward activity. Rather, because all of the cognitive processing that goes on in job training and job performing is hidden within people's minds, the analyst can only infer processing from tasks that people perform in job training or performance. The analyst must operate from some conceptual understanding of the basic skills of interest and the cognitive processes they involve. Examples of conceptual frameworks were given in the case studies reported previously. For instance, the basic skills of reading to do something in contrast to reading to learn something were distinguished on the basis of the information processing differences involved in the two types of tasks. Detailed methods for basic skills analysis are given in Smith (1973), Diehl and Mikulecky (1980), and Sticht et al. (1976).

In determining basic skills requirements of work, two aspects of requirements may become of concern. On the one hand, managers and others who are primarily concerned with basic skills so that screening and job classification may be more effectively accomplished would be concerned with knowing the general level of reading or mathematics required for successful performance in training or on the job. Thus, they will desire some sort of summary index number, such as a reading grade level, that characterizes the basic skills requirements of jobs. Trainers, on the other hand, are more concerned with knowing the basic skills tasks that must be performed so that curricula for basic skills training can be developed. Because of these dual approaches to analysis of basic skills requirements (i.e., summary index numbers and task statements), the analyst may find the approaches described in the FLIT case study of interest (Chapter 3).

Design

Given the need for basic skills training and an understanding of the basic skills tasks to be learned, the next activity is to design an instructional program. In this regard, a factor of special importance for basic skills training for business or industry is to simulate the job requirements to the greatest extent possible. This will ensure the most rapid learning of the job basic skills and their transfer to the job setting, whether that is a training or performance station.

The design of basic skills programs should proceed on the basis of the four principles discussed. Where very low literacy is of concern, the design of learning activities should proceed from experience with the materials that are to be used, accompanied by oral language learning of vocabulary, concepts, and job principles and rules. Reading assignments should build on this prior experiential and oral language base of knowledge. Extended practice should be designed into all activities for adequate levels of skill to be attained.

Development

The development process includes the specification of the actual learning activities in which the trainees will engage and the organization of the activities (including tests) into an overall systematic program of basic skills training. For lower skill levels, it may be necessary to develop simplified approximations of real job materials, such as simplified prose passages from technical manuals, partial forms (some industrial forms are very long and complex), and procedural directions with only a few steps per page to be read and performed. Eventually, however, the materials should become as difficult as those to be used on the job.

Tests should be developed that measure the actual performance of job reading, oral language, or mathematics tasks, and the instruction should be such that the tests are sensitive to it. That is, one ought to test to determine if what is being taught is being learned. To the extent possible, the principles of time on task and competency-based instruction ought to guide the development activity.

Implementation

During the implementation phase, the curriculum materials are tried out and revisions are made where necessary. It is important that the entire curriculum and training management system be allowed to operate for some time in order to determine how well materials and procedures are working out.

In addition to permitting the tryout and revision of materials and methods, the implementation activity may extend to the actual operationalization of the new program. If so, then considerable attention should be given to establishing the social networks within and outside the organization that will have to support the program. Within the organization, this means that all parties involved, from highest-level management to the potential students, must be informed of the program and its purposes. Any effects of the program on various organizational departments, such as the personnel department, should be made explicit. Outside the organization, agencies such as schools, government offices, and community-based organizations that may act to support the program through referrals, follow-up, and so forth should be contacted and given a briefing on the program and its purposes. These activities may reveal important factors that need to be incorporated into the design of the program, so implementation activities should not be postponed until a program is completely developed. Rather, planning for implementation should occur as one of the earliest activities.

Social networks should be taken into consideration in yet another sense. Employees constantly draw upon each other's knowledge and expertise to solve problems. Research has shown that workers on the job ask questions of each other nearly twice as often as do students in school (Mikulecky 1982). Trainees in all three case studies sometimes worked cooperatively in both study and job performance and developed social networks as a result. These useful social networks, which provided both intellectual and emotional support, can be built into basic skills and technical training programs.

For job skills programs it is essential that the individual workers be informed about the program and that social networks for encouraging individual participation be established. Many lower-skilled adults may feel reluctant about entering into a basic skills program, so it is better to refer to the program as a job skills training program and to build the social support networks that will aid in the recruitment and support of trainees (Harman, 1987, presents a useful discussion of social interactions in literacy programs, including work-oriented programs).

Evaluation

If there is one point at which most program developers fall short, it is in determining the value of the program. Very few basic skills, or, for that matter, technical skills training programs gather adequate quantitative and qualitative information to determine whether or not the program is cost-beneficial; that is, whether the benefits of the program outweigh the costs of developing and conducting the program. While this is admittedly difficult to do, program developers should attempt to do the best evaluation they can. At a minimum, a program that purports to develop certain cognitive skills in trainees should demonstrate the extent to which such skills are, indeed, acquired. Thus, for instance, if the program purports to improve job literacy or numeracy skills, then the evaluation method should include procedures for indicating that trainees can perform reading and mathematics tasks better at the end of training than they could at the beginning of training. Such demonstrations should be possible if the principle of competency-based instruction is followed. The case studies reported in Chapters 3 and 4 contain examples of evaluation methods that may be of use to those desiring to develop and evaluate occupationally oriented basic skills programs.

REFERENCES

Anderson, T. H. & Armbruster B. B. (1985). Studying strategies and their implications for textbook design. In T. Duffy & R. Waller (Eds.), Designing Usable Texts. New York: Academic Press.

Askov, E. (1987, January). Chapter I Parent Literacy Programs. University Park, PA: Institute for the Study of Literacy, The Pennsylvania State University.

Beller, E. (1973). Research on organized programs of early education. In R. Travers (Ed.), Second Handbook of Research on Teaching. Chicago: Rand McNally College Publishing Co.

Bormuth, J. (1985). A response to "Is the Degrees of Reading Power test valid or invalid?" Journal of Reading, 29, 42-47.

Bransford, J. & Johnson, M. (1972). Contextual prerequisites for understanding. Some investigations of comprehension and recall. Journal of Verbal Learning and Verbal Behavior, II, 717-726.

Bronfenbrenner, U. (1975). Is early intervention effective? In M. Guttentag and E. Struening (Eds.) Handbook of Evaluation Research, Vol. 2, London: Sage Publications.

Brown, D. P. (1954). Auding as the primary language ability. Unpublished Doctoral Dissertation, Stanford, CA: Stanford University.

Carroll, J. & Chall, J. (Eds.) Toward a Literate Society. New York: McGraw-Hill, 1975.

Chall, J., Heron, L. & Hilferty, A. (1986). Survey of adult literacy programs in Cambridge/Boston. Cambridge, MA: Harvard Graduate School of Education.

Chang, F. R. (1985, October). Literacy, Readability, and Knowledge. Paper presented at the annual meeting of the Military Testing Association, San Diego, CA.

Datta, L. (1982). Employment-related basic skills. In H. Silberman (Ed.) Education and Work. Chicago. IL: The University of Chicago Press.

Department of Defense (1972, March). Profile of American Youth. Washington, DC: Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics).

Diehl, W. & Mikulecky, L. (1980). The nature of reading at work. Journal of Reading, 24, 221-227.

Farr, B. (1983, April). Symposium on Basic Skill Instruction in the Military. Montreal, Canada: Annual Meeting of the American Educational Research Association.

Fisher, D. (1978). Functional Literacy and the Schools. Washington, DC: National Institute of Education.

Fox, M. (1986, July). A look at illiteracy in America today—the problem, the solutions, the alternatives. Washington, DC: Push Literacy Action Now.

Fox, W., Taylor J. & Caylor J. (1969, May). Aptitude Level and the Acquisition of Skills and Knowledges in a Variety of Military Training Tasks. HumRRO TR 69-6. Alexandria, VA: Human Resources Research Organization.

Goffard, S., Polden D. & Ward J. (1970). Development and evaluation of an improved radio operator course. Hum RRO-TR-70-8. Alexandria, VA: Human Resources Research Organization.

Golden, M. & Birns B. (1976). Social class and infant intelligence. In M. Lewis (Ed.) Origins of Intelligence: Infancy and Early Childhood. New York: Plenum Press.

Harmon, D. (1987). Illiteracy: A National Dilemma. New York: Cambridge Book Company.

Harris & Associates (1970, August). The 1971 National Reading Difficulty Index: A Study of Functional Reading Ability in the U.S. for the National Reading Center. New York: Harris and Associates.

Hess, R. & Holloway S. (1979, June). The Intergenerational Transmission of Literacy. Report prepared for the National Institute of Education.

Kirsch, I. & Jungeblut A. (1986a). Literacy: Profiles of America's Young Adults. Report No. 16-PL-02. Princeton, NJ: Educational Testing Service.

Kirsch, I. & Jungeblut A., etc. (1986b). Literacy: Profiles of America's Young Adults—Final Report. Report No. 16-PL-01. Princeton, NJ: Educational Testing Service.

Koffman, N., Allen M., and Sticht T., etc. (1985, March). Navy Campus Functional Skills Program: Information Processing Skills: Reading. Pensacola, FL: Chief of Naval Education and Training.

Koffman, N., Allen M., Armijo L., George K., Joelson J., Powers J., Roberson K. & Sticht T., etc. (1986, September). Mathematics for Navy Career Progression: Information Processing Skills. Pensacola, FL: Chief of Naval Education and Training.

Laboratory of Comparative Human Cognition (1982, July; 1985, August). Quarterly Newsletter. La Jolla, CA: University of California, San Diego.

Loban, W. Language Ability Grades Seven, Eight, and Nine. Project No. 1131, University of California, Berkeley, March 1964.

Mikulecky, L. (1982). Job literacy: The relationship between school preparation and workplace actuality. Reading Research Quarterly, 17, 400-419.

Mikulecky, L. & Stranse R. (1984). Effective literacy training programs for adults in business and municipal employment. In J. Orasanu (Ed.), A Decade of Reading Research: Implications. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Mikulecky, L. & Cousin P. (1982). Literacy training in business: A Survey of Fortune 500 Training Programs. Performance and Instruction, 21, 29-30.

Mikulecky, L. & Winchester, D. (1983). Job literacy and job performance among nurses at varying employment levels. Adult Education Quarterly, 34, 1-15.

Miller, P. (1982, November). Reading demands in a high technology industry. Journal of Reading, 26, 109-115.

Neisser, V. (1967). Cognitive Psychology. New York: Appleton-Century-Crofts.

Park, R. (1984). Improving basic skills in the workplace. Training and Development Journal. pp. 76-80.

Ryan, T. & Furlong W. (1975). Literacy programs in industry, the Armed Forces, and penal institutions. in J. Carroll & J. Chall (Eds.), Toward a Literate Society. New York: McGraw-Hill.

Rouse, W. & Morris N. (1985). On looking into the black box: prospects and limits in the search for mental models. (Report No. PS-2). Atlanta, GA: Georgia Institute of Technology, Center for Man-Machine Systems Research.

Rumelhart, D. (1980). Schemata: The building blocks of cognition. In R. Spiro, B. Bruce, and W. Brewer (Eds.) Theoretical Issues in Reading Comprehension. Hillsdale, NJ: Lawrence Erlbaum.

Rush, R., Moe, A. & Storlie, R. (1986). Occupational Literacy Educations. Newark, DE: International Reading Association.

Sacher, J. & Duffy T. (1977). Reading skill and military effectiveness. Paper presented at the American Educational Research Association meetings.

Schrank, R. & Stein S. (1970, June). Basic education: what are the realistic possibilities. In: Training in Business and Industry.

Schwartz, S. H. (1971). Modes of representation and problem solving: well evolved is half solved. Journal of Experimental Psychology, 2, 347-350.

Shoemaker, H. (1960). The functional context method of instruction. IRE Transactions on Education, E-3, 54-58.

Shoemaker, H. (1967). The functional context method of instruction. HumRRO Professional Paper No. 35-67, Alexandria, VA: Human Resources Research Organization.

Sticht, T. (1972). Learning by listening. In R. Freedle & J. Carroll (Eds.) Language Comprehension and the Acquisition of Knowledge. Washington, DC: V. H. Winston & Sons.

Sticht, T. (Ed.) (1975a). Reading for Working. Alexandria, VA: Human Resources Research Organization.

Sticht, T (1975b). A Program of army functional job reading training. HumRRO FR-WD-CA-75-7. Alexandria, VA: Human Resources Research Organization.

Sticht, T. (1978). The acquisition of literacy by children and adults. In F. Murray and J. Pikulski (Eds.) The Acquisition of Reading. Baltimore, MD: University Park Press.

Sticht, T. (1979). Developing literacy and learning strategies in organizational settings. In H. O'Neil, Jr. and C. Spielberger (Eds.) Cognitive and Affective Learning Strategies. New York: Academic Press.

Sticht, T. (1982a, March). Basic Skills in Defense. Washington, DC: Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics).

Sticht, T. (1982b). Literacy at work. In B. Hutson (Ed.), Advances in Reading Language Research (Vol. I). Greenwich, CT: JAI Press.

Sticht, T. (1982c). Evaluation of the reading potential of marginally literate adults (Tech. Memorandum 82-5). Washington, DC: Office of the Secretary of Defense, Directorate for Accession Policy.

Sticht, T. (1983). Literacy and human resources development at work: Investing in the education of adults to improve the educability of children. HumRRO-PP-2-83. Alexandria, VA: Human Resources Research Organization.

ERIC

Sticht, T. (1985). Understanding readers and their uses of text. In T. Duffy and R. Waller (Eds.), Designing Usable Texts. New York: Academic Press.

Sticht, T. & Mikulecky L. (1984). Job-related basic skills: cases and conclusions. Information Series No. 285. Columbus, OH: The Ohio State University, ERIC Clearinghouse on Adult, Career, and Vocational Education.

Sticht, T. & Beck L. (1976, June). Development of an experimental literacy assessment battery. AFHRL-TR-74-36. Lowry, AFB, Colorado: Air Force Human Resources Laboratory, Technical Training Division.

Sticht, T. & James J. (1984). Listening and reading. In P. Pearson (Ed.), Handbook of Research on Reading. New York: Longmans.

Sticht, T. & McFann H. (1975). Reading requirements for career entry. In D. Nielsen & H. Hjelm (Eds.), Reading and Career Education. Newark, DE: International Reading Association.

Sticht, T. & Zapf D. (Eds.) (1976, September). Reading and readability research in the armed services. HumRRO FR-WD-CA-76-4. Alexandria, VA: Human Resources Research Organization.

Sticht, T., Fox L., Hauke R. & Zapf D. (1976, September). Reading in the Navy. HumRRO FR-WD-CA-76-14. Alexandria, VA: Human Resources Research Organization.

Sticht, T., Chang F. & Woods F. (Eds.). Cognitive Science and Human Resources Management (Advances in Reading/Language Research, Vol. 4). Greenwich, CT: JAI Press.

Sticht, T., Armstrong W., Hickey D. & Caylor J. (1987). Cast-off Youth: Policy and Training Methods from the Military Experience. New York: Praeger.

Sticht, T., Beck L., Hauke R., Kleiman G. & James J. (1974). Auding and Reading: A Developmental Model. Alexandria, VA: Human Resources Research Organization.

Sticht, T., Armijo L., Weitzman R., Koffman N., Roberson K., Chang F. & Moracco J. (1986, February). Teachers, books, computers and peers: Integrated communications technologies for adult literacy development (a summary program report). Monterey, CA: U.S. Naval Postgraduate School.

Wallace, M.C. (1965). Literacy Instructor's Handbook. Chicago: Follett Publishing Company.

96

END

U.S. Dept. of Education

Office of Educational
Research and Improvement (OERI)

ERIC

Date Filmed
August 1, 1992

ERIC
Full Text Provided by ERIC